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THE GLASS INDUSTRY

THE JOURNAL OF GLASS MANUFACTURING

DECEMBER 1959

- *Christmas Glass*
- *Glass Mfg.: Dry Compressed Air*
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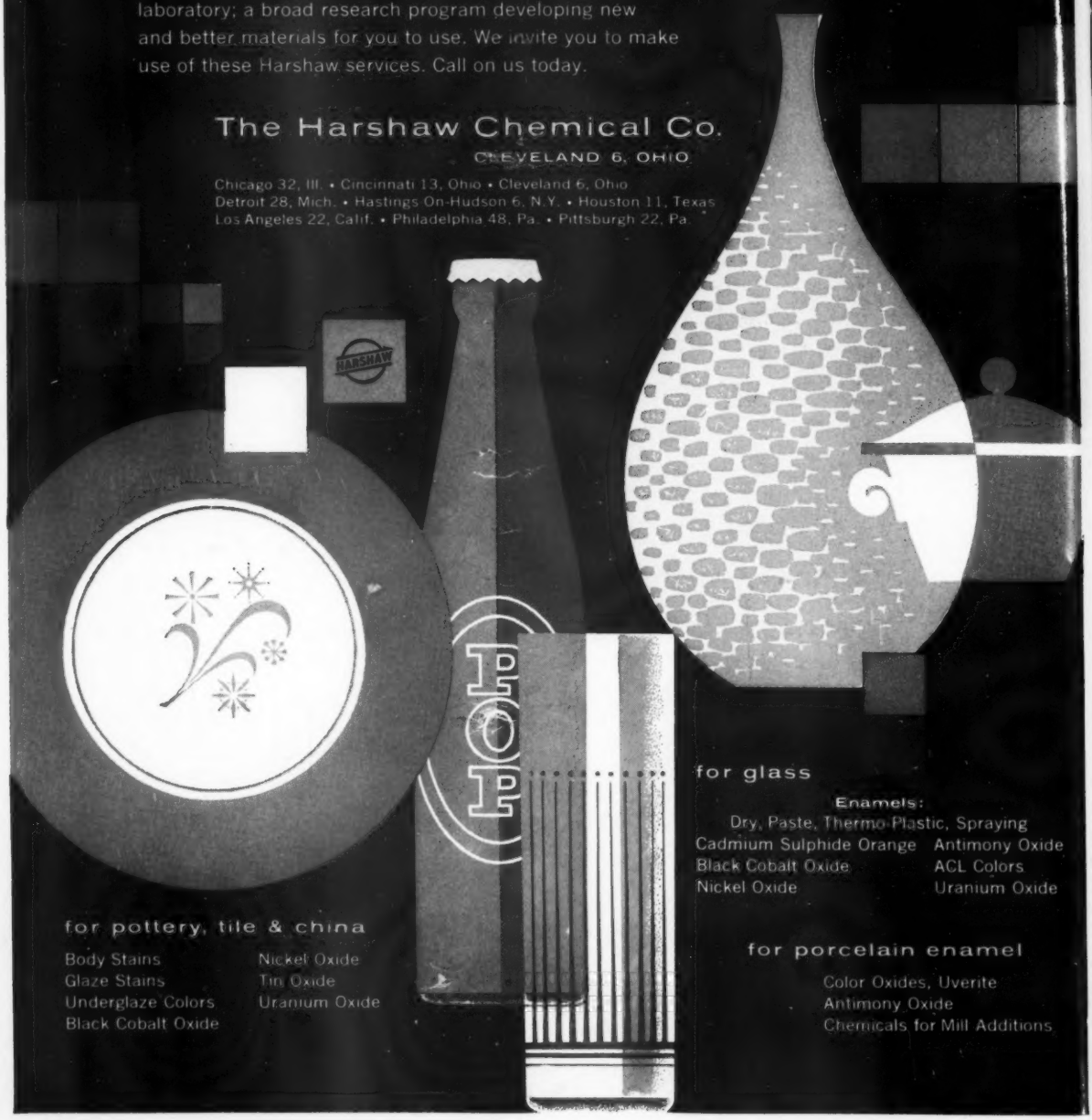

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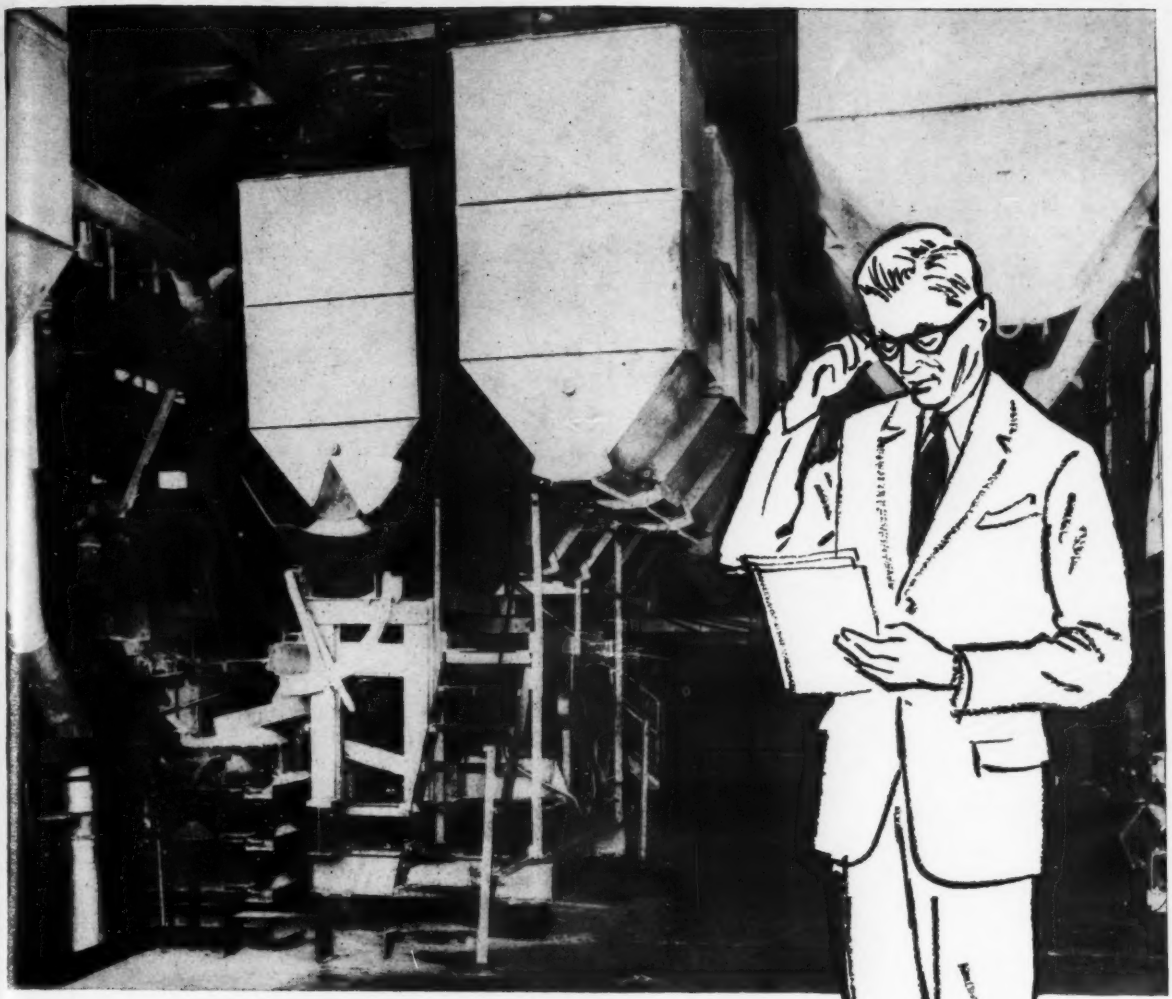

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THE GLASS INDUSTRY

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Merry Christmas! What better way to say it than through the medium of glass? Glass has an unparalleled versatility which is exemplified by these figurines, the work of Mr. H. Bruckdorfer of St. Louis, whose vocation and avocation are both in glass. On page 693 he tells how he forms these sparkling figures . . . Only the glass man can know the feeling of accomplishment derived from such artistry.

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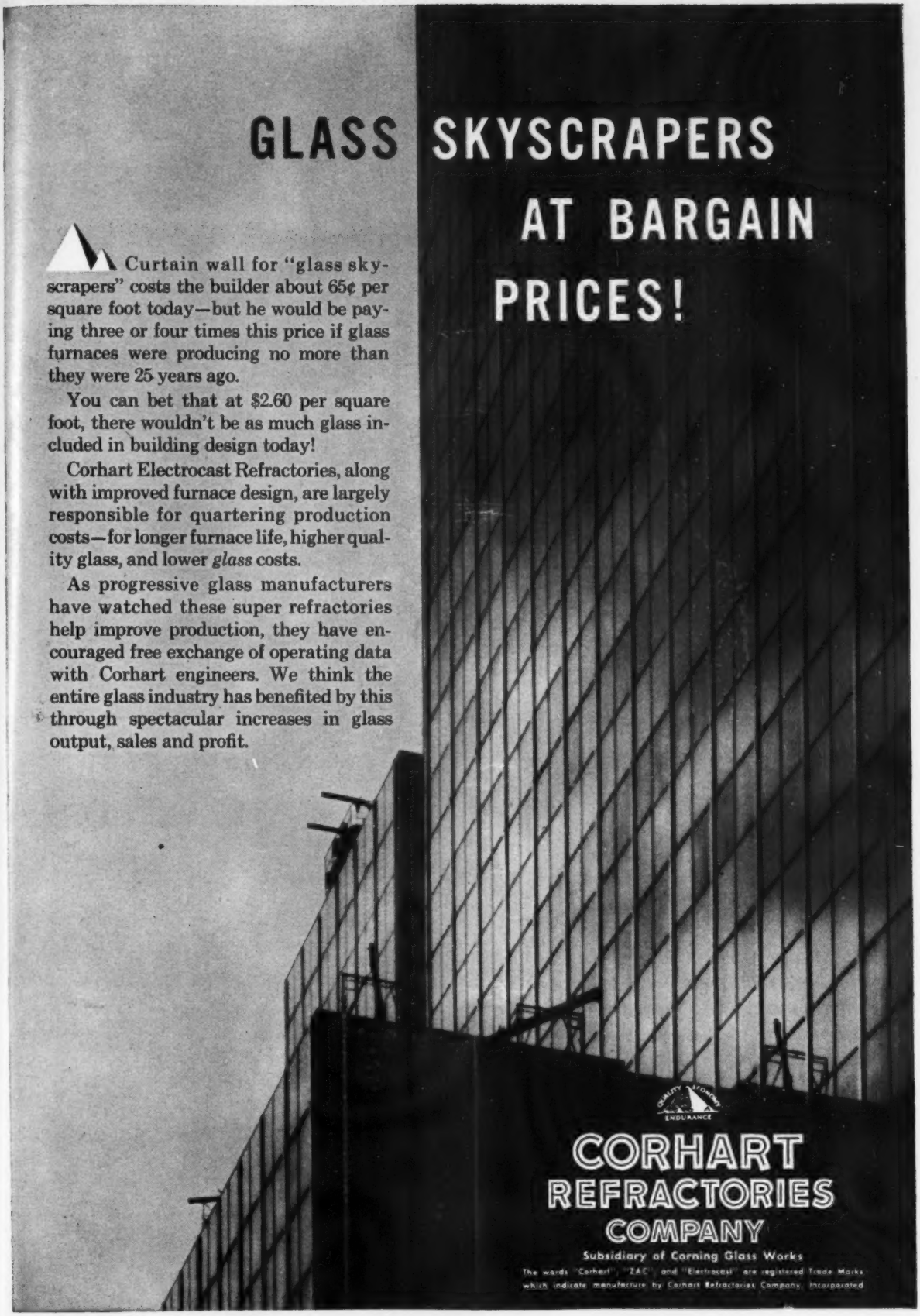

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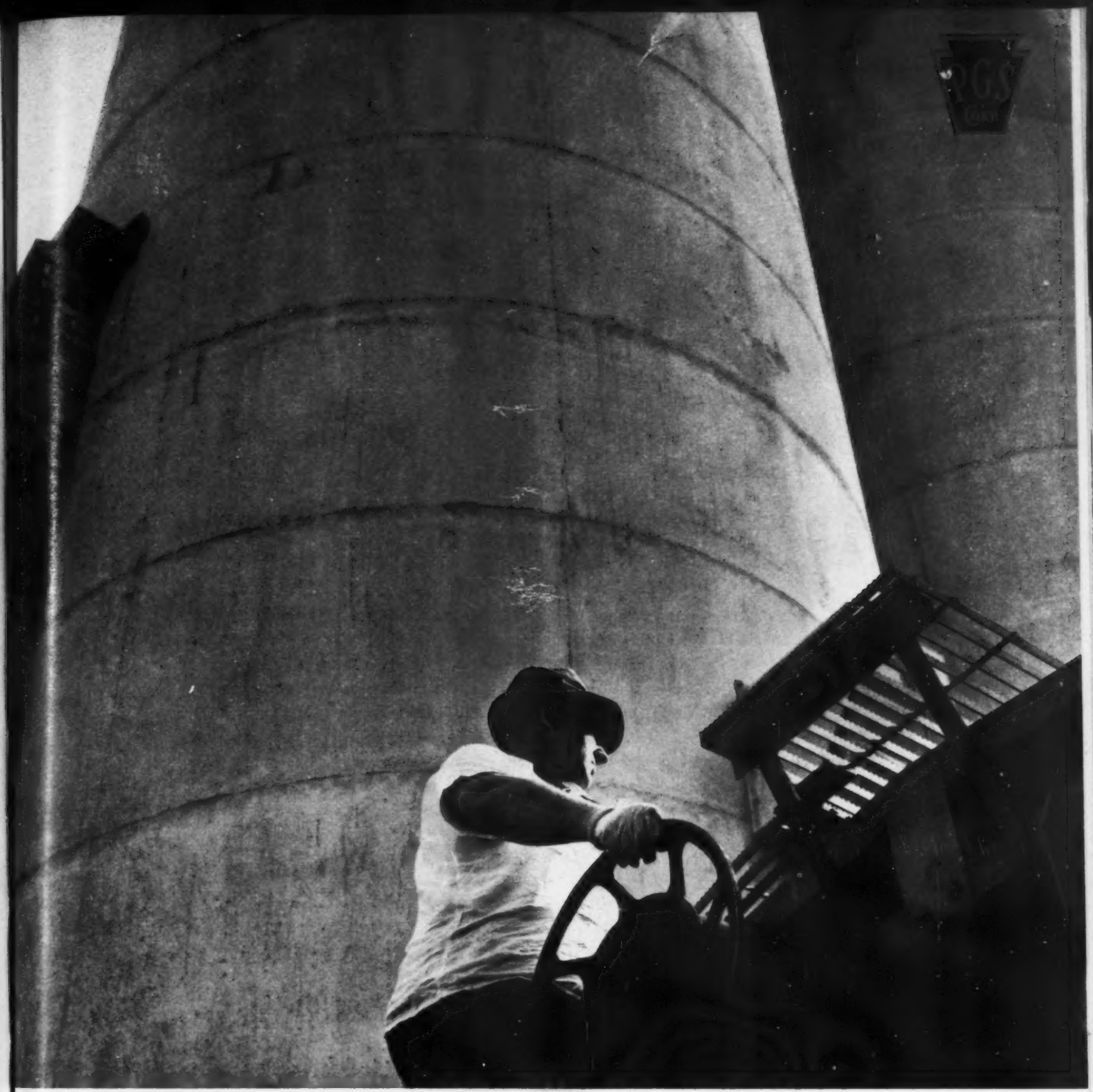

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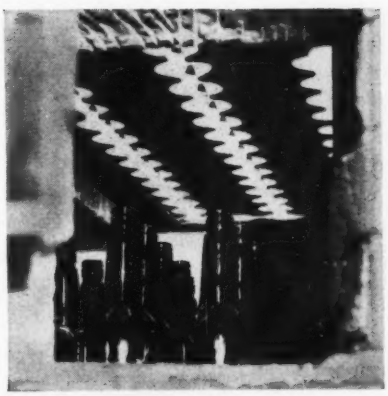

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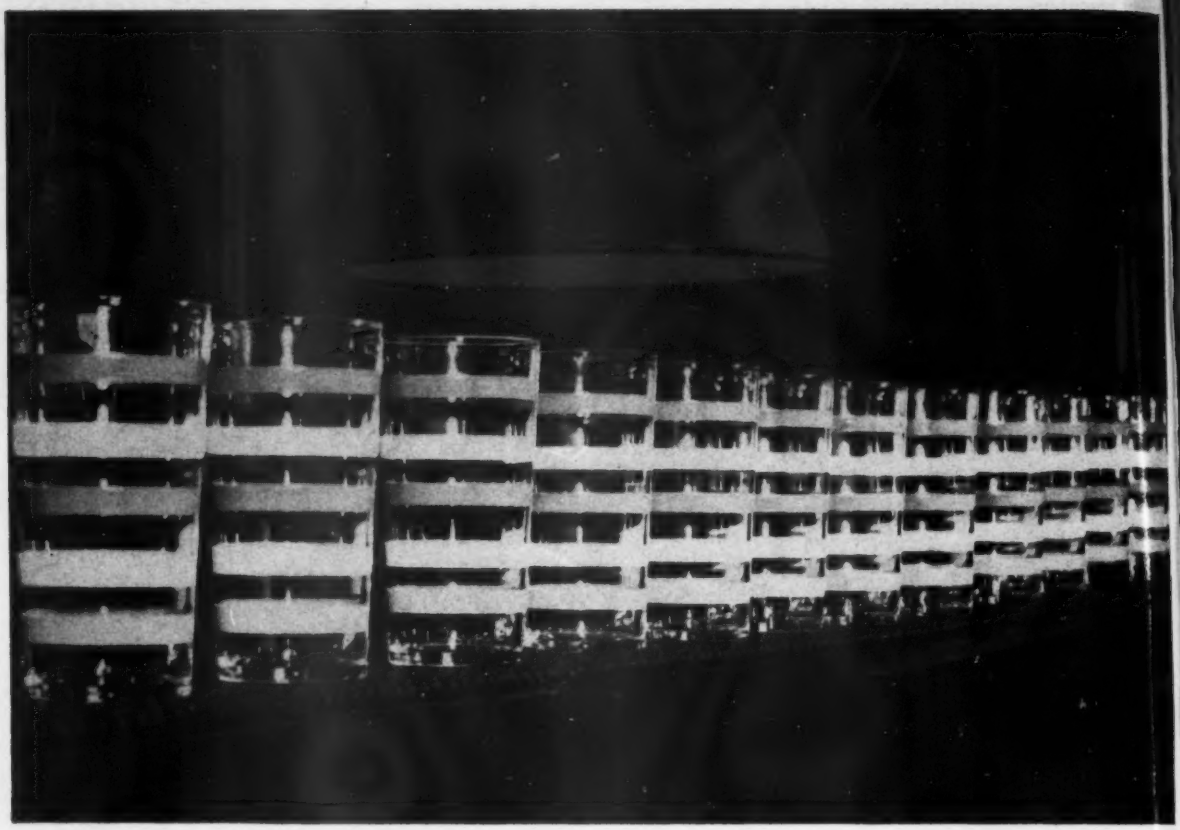

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THE GLASS INDUSTRY
THE JOURNAL OF GLASS MANUFACTURING

GLASS DIVISION MEETING

(October 15 and 16)

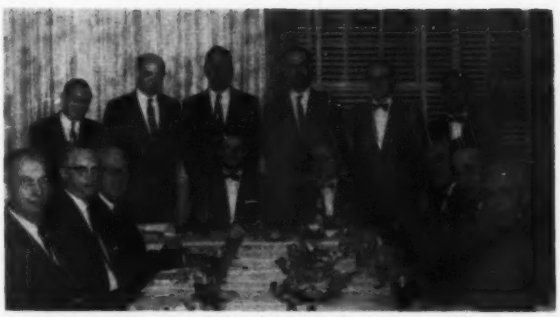
● THE FALL MEETING of the Glass Division of the American Ceramic Society was held this year in Wernersville, Penna., at Galen Hall in the heart of the picturesque Pennsylvania Dutch country. Total registration included 350 glass technologists, their wives, and their friends.

An outstanding technical program of more than 20 papers plus a Workshop (Strength Measurements of Glass) had been developed by the program committee: Robert D. Maurer, Chairman, Corning Glass Works; Clarence L. Babcock, Owens-Illinois Technical Center; and Harold E. Simpson, State University of New York, College of Ceramics, Alfred University.

The 2-day session was further highlighted by a golf tournament, banquet, and dancing. The ladies' program, which ended with a luncheon Friday noon, was well planned by the following committee, of which Mrs. D. Owen Evans was Chairman: Mrs. Clarence L. Babcock, Mrs. Frank R. Bacon, Mrs. Fred L. Bishop, Mrs. Charles A. Bradley, Jr., Mrs. Charles L. Cruikshank, Mrs. John C. Denison, Jr., Mrs. Charles H. Greene, Mrs. Charles E. Gum, Mrs. Joseph C. Keaney, Jr., Mrs. Victor V. Kelsey, Mrs. Howard R. Lillie, Mrs. William H. Manring, Mrs. Frank W. Preston, Mrs. Victor H. Remington, Mrs. August C. Siefert, Mrs. Harold E. Simpson, Mrs. Dudley C. Smith, and Mrs. Julius J. Torok.

Technical Session

The technical session was opened Thursday morning with a "Symposium on Radiation Effects," arranged by



Left to right: Seated. Fred W. Mowrey, Fred L. Bishop, Norbert Kreidl, Fay V. Tooley, Frank Bacon, Leonard G. Ghering, Clarence Babcock, and Harold E. Simpson. Standing. William H. Manring, Neill M. Brandt, August C. Siefert, John W. Michener, J. R. Hensler and Guy E. Rindone.

Norbert J. Kreidl, Bausch and Lomb Optical Company, Rochester, New York. This was guided by Frank R. Bacon, Owens-Illinois, Toledo, Ohio, and Dr. Kreidl.

Radiation Induced Absorption, by J. R. Hensler, Bausch and Lomb Optical Company. Reviewed the work of many investigators, presenting a background of the radiation-induced absorption effects in glass.

Absorption bands formed in glass exposed to high energy radiation vary with the network former, with the type and amount of modifiers present in gross amounts, with small amounts of transition elements, and in the example of fused silica, with minute amounts of impurities. The stability of the induced absorption

bands varies, with all bands being eliminated by heating to sufficiently high temperatures. This bleaching is accompanied by light emission (thermoluminescence).

In alkali-lime-silica glasses, assignments of radiation induced bands, some of which vary strongly with the type of alkali, have been proposed. High purity fused silica is extremely resistant to coloration by radiation. High-purity fused germania shows absorption bands attributed to germanium in a reduced valence state. A color center associated with aluminum-lithium impurity in silica has been analyzed in smoky quartz and synthesized in high purity silica. The synthesis led to a generalization of the impurities which, paired with aluminum, would produce the color center. Another absorption band found in irradiated fused silica has been shown to be due to germanium impurity, and a mechanism for its formation in the presence of the aluminum center has been proposed.

Undoped silica exposed to radiation showed strong thermoluminescence. The comparison of this thermoluminescence with that of aluminum-lithium doped silica aids in the interpretation of the bleaching mechanism.

Radiophotoluminescence and Radioluminesence of Glass by R. J. Ginther, Naval Research Laboratory, Washington, D. C. It has been found that most of the phenomena observed upon radiation treatment of crystal phosphors can also be obtained with glassy systems. One of these effects is radiophotoluminescence, the luminescence produced by ultraviolet excitation of stable luminescent centers created by treating glass with X-rays or gamma rays. The employment of this phenomenon in a silver-activated phosphate glass is the basis of the casualty range gamma ray dosimetry system of the United States Navy and of a small needle-type dosimeter used in radiation therapy. The optical properties of the glass as a function of radiation treatment and a description of the dosimetry systems employed were presented.

Radioluminescence, the luminescence directly excited in a phosphor material by radiation from X-rays or gamma-rays, finds extensive application in scintillation counters. The advantages and requirements of a glass scintillator were discussed, and progress in the development of such a detector at the Naval Research Laboratory was reported.

Radiation Induced Nucleation, by S. D. Stookey, Corning Glass Works, Corning, New York. Discussed chemical and physical changes that are initiated in appropriate glasses by ultraviolet and by X-irradiation. The current theories concerning some reaction mechanisms were reviewed, with emphasis on the importance of the fact that the chemical species in glass are not in thermodynamic equilibrium at room temperature. Oxidation-reduction and crystal nucleation in photosensitive glasses were considered.

THURSDAY AFTERNOON

The Thursday afternoon session of the Symposium was under the chairmanship of Dr. Kreidl.

Trapped Electrons in Silica and Quartz, by R. A. Weeks and C. M. Nelson, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Presented by Mr. Nelson.

Previous studies have associated the 2100 Å absorption band with an electron spin resonance line developed in silica and quartz after irradiation. Evidence derived from bleaching studies at 78°K after γ-irradiation indicated that an absorption band at 2300 Å in synthetic quartz is associated with another spin resonance system described in the next paper by the same authors. After 10^9R, G. E. Ltd. synthetic quartz slowly developed this band rather than the 2100 Å band.

The 2300 Å band was also produced in high-purity fused silica as shown by bleaching at 78°K with a 4W mercury germicidal lamp (glass envelope); as the 2300 Å band decreased, there was a corresponding increase in the 2100 Å band. Though the 2100 Å band is predominate in silica after irradiation, bleaching experiments indicated that the 2300 Å band was at least three times the concentration found in synthetic quartz for an equivalent γ-irradiation. Bleaching with a Uviarc mercury (silica envelope) lamp reversed the process (the 2100 Å band decreased while the 2300 Å band increased) at 78°K in silica. Using G. E. Ltd. quartz, bleaching with a germicidal lamp at 78°K decreased the 2300 Å with no apparent increase in the 2100 Å band. This transfer to the 2100 Å band occurred at room temperature and in natural quartz at 78°K where there was already some 2100 Å band present. Annealing quartz up to 300°C. caused an increase in the 2100 Å band; however, the band completely disappeared as the temperature approached 450°C. Upon annealing, synthetic silica always showed a decrease in the 2100 Å band.

Trapped Electrons in Irradiated Quartz and Silica; Part II, Electron Spin Resonance, by C. M. Nelson and R. A. Weeks, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Presented by Mr. Weeks. Several systems of ESR (electron spin resonance) lines have been observed in γ-irradiated natural and synthetic crystals. The correlation of one system of lines with an optical absorption band at 2300 Å, also observed in the crystals, has been established. The correlation was made by observations on irradiated crystals of differing origin and by bleaching experiments conducted at 78°K. The system of ESR lines is composed of two lines when the c-axis [001] is parallel to H, while for the [100] orientation six lines may be distinguished. Owing to the complexity of the spectrum and small anisotropy, accurate measurements of the g tensor orientation and eigenvalues have not been made; estimates of the eigenvalues are $g_1 \approx 2.0004$, $g_2 \approx ?$, $g_3 \approx 2.0020$; while for the [001] orientation g is 2.0007 and 2.0009.

This ESR system and the 2300 Å band which have also been observed in neutron-irradiated crystals, grow with increasing irradiation. The presence of the optical band in irradiated high-purity silica and its growth with continuing neutron irradiation apparently eliminated impurity ionization states as a source of the defect.

A comparison of the anisotropy and Δg ($\Delta g = g_{center} - g_{free\ electron}$) of this center with similar quantities for the ESR system tentatively associated with an electron trapped at an 0 vacancy suggested that this defect has a similar environment. The separation of the two lines for the [001] orientation, $\Delta H \approx 0.4$ oersted, is in agreement with the difference in angle that 2 of the Si-O bond directions formed with the [001] direction. It was suggested that this defect may be a dangling Si bond which can trap an electron.

Synthesized Impurity Centers in Fused Silica, by E. Lell, Bausch and Lomb Optical Company, Rochester, New York. The formation of color centers in alkali halides is a property of the structure and does not depend on impurities within the structure. Even the purest alkali halides form color centers under irradiation. Unlike alkali halides, quartz of very high purity shows no coloration under ionizing radiation. Complex glasses, however, as well as quartz crystals and quartz glass, which have not been carefully purified, form color centers. It must be concluded, therefore, that color centers in silica are caused by impurities which disturb the silica network in glass and crystals.

Fused silica was prepared with controlled amounts (0.02-2.0 per cent) of aluminum and lithium added. Absorption spectra and thermoluminescence revealed little difference between undoped samples and samples containing Li or Al alone. However, the simultaneous presence of Al and Li was essential to build up the absorption band at 2.3 eV (520 mμ) and increase the intensity of the bands at 4.1 eV (300 mμ) and 5.7 eV (220 mμ). A quantitative dependence between impurities and absorption of the 3 bands was given. Although all samples show luminescence peaks at 120°C., samples containing Al and Li simultaneously evidenced an additional peak at 310°C.

Thermoluminescence of Vitreous GeO_2 After U.V. Excitation, by V. Garino-Canina, St. Gobain, Paris, France. The results presented in this paper were obtained with vitreous GeO_2 prepared by relatively fast cooling from the molten oxide.

The apparatus for the study of thermoluminescence comprised the following:

1. A heating element (in a little cavity of which the sample was placed), fed in a way assuring linear increase of temperature. The temperature was measured by a thermocouple, the junction of which was placed about 1 mm. from where the powder was located.
2. An optical quartz system forming the image of the sample on the photocathode of a photomultiplier.
3. A photomultiplier tube which was sensitive in the UV and the visible. The high impedance signal appearing at the terminals of the load resistor entered an amplifier of less than unity gain and of high input impedance.
4. A galvanometer placed at the output of the amplifier, the deflections of which were registered by a spot follower.

Curves were shown representing the photomultiplier signal as a function of sample temperature. For vitreous GeO_2 samples there existed in every instance an emission peak between 50 and 70°C. In addition, peak height increased with alumina content. It was also observed that the position of the maximum was displaced from 50 to 70°C. when the Al_2O_3 content approached 5 per cent.

These results caused the author to suspect the purity of "pure" GeO_2, and, indeed, spectrographic analysis showed a content, among other impurities, of about 10 ppm of aluminum. Thus thermoluminescence appears to be related to the presence of the aluminum impurity in GeO_2 glass.

It is known that the Al impurity acts upon the 2450 Å absorption band of vitreous GeO_2, formed as a result of an oxygen deficiency. The mechanism of the action of Al seemed to involve controlling the valence state of germanium in its oxide form. The observed phenomena of thermoluminescence—the interpretation of which appears premature—furnished complementary information which will permit better understanding of the detailed mechanism of the Al impurity in GeO_2 glass.

The introduction of between 5 and 10 per cent alumina into vitreous germanium oxide produced a thermoluminescence phenomenon excited by UV radiation and characterized by the following:

1. A peak position between 50°C and 70°C.
2. A peak height increasing with the alumina introduced into the GeO_2 glass.

The Kinetics of Gamma Ray Induced Coloring of Glasses, by Paul W. Levy, Brookhaven National Laboratory, Upton, New York. When glasses are subjected to purely ionizing radiation, such as X-rays or gamma-rays, the principal effects result from purely electronic processes. Specifically, these effects occur because electrons are excited sufficiently to leave their normal positions and move through the glass network. In some glasses these ionization processes are purely transient, and after the radiation field is removed, the electron distribution remains the same as it was originally, especially if the sample is kept at a sufficiently high temperature. In other glasses the electron distribution is permanently altered. By analogy with similar processes in crystals, it is well established that the coloring of glass by ionizing radiation is the result of the redistribution of electrons. In particular the addition or removal of one or more electrons from defect or impurity centers results in the formation of a center that can absorb light, i.e., a color center.

When glasses are colored by ionizing radiation, the induced optical absorption, which increases as the radiation progresses, appears to be due to the superposition of a number of individual absorption bands. A detailed study of this process was made using a sample of Corning borosilicate glass colored by exposure to Co^{60} gamma-rays, this particular sample being chosen because only 4 bands are formed. If it is assumed that each band is Gaussian shaped, the spectrum may be separated into 4 absorption bands.

The peak energy E_0 and full width U of these bands were stated in electron volts: $E_0 = 4.85$, $U = 1.19$; $E_0 = 3.95$, $U = 1.30$; $E_0 = 2.58$, $U = 0.58$; $E = 2.02$; $U = 0.52$. For each band, growth curves may be constructed showing how the density of absorption centers increased as a function of dose. These growth curves were fitted with theoretical curves based on the following considerations: the radiation field created ionization electrons in the glass; for each ionization electron one electron-deficient region or hole was formed; absorption bands observed were due to centers formed by electron trapping; and, competition for ionization electrons existed between holes and the various kinds of electron traps. Satisfactory agreement between the observed and calculated curves was obtained. The theory indicated that the "radiation protection" imparted to glass by materials such as CeO_2 may develop in several different ways and that it would be possible to select the best way through the use of simple experiments.

Radiation Induced Coloration in Glass, by W. H. Cropper, Sandia Corporation, Albuquerque, New Mexico. This paper was not formally presented but the following abstract is given. An approach was presented to the elementary processes which lead to color-center formation. It was assumed that the energy of the primary and secondary particles of the radiation was dissipated in a track and that the free electrons and positive holes were initially produced in this track. The decay of the track from this initial condition may then involve the following:

a. Recombination of positive holes and electrons.
b. Interaction between trapping centers and electrons to form color centers.
c. Diffusion of electrons away from the track.
d. Diffusion of positive holes away from the track.
e. Interaction between positive holes and color centers.
f. Spontaneous decay of color centers.
g. Destruction of color centers in regions of localized high temperatures and electronic excitation.

Under certain conditions all the processes listed above may be important, with a theoretical calculation of the color-center yield becoming very complicated. In this paper a useful simplification was introduced by separating the processes which may be of importance in the track (processes *a*, *b*, and *c*) from those which are slower (processes *d*, *e*, and *f*) and occur after the track has mostly decayed. It was shown that process *g* did not significantly affect color-center production at the concentrations usually encountered.

Thus, the problem was considered in 2 stages: (1) the initial production of electrons in the track and their subsequent competitive capture by positive holes and trapping centers, and (2) the effects of slower processes, all of which contribute to the destruction of color centers. These 2 stages were considered independent of each other and were discussed separately.

The Annealing of Radiation-Damaged Silver Activated Phosphate Glass, by R. A. Kramer, Rensselaer Polytechnic Institute, Troy, New York. A study was made of the kinetics of the annealing of color centers introduced in silver-activated phosphate glass (SAPG) by gamma radiation from Co^{60}. The annealing was studied at temperatures between 150°C. and 300°C. and over a concentration range of color centers which varied by a factor of four. The results of the study showed that the fraction annealed (ψ) was a function of the square root of the annealing time ($t^{1/2}$), and that the diffusion of "F" centers and "V" centers formed by gamma irradiation was presented as explaining the annealing curves obtained. An energy of activation of 12.3 K cal/mole for the diffusion was calculated from an Arrhenius plot of the initial slope of ψ versus $t^{1/2}$. A mechanism was proposed to explain the annealing data and fluorescent properties of irradiated SAPG, and a second order differential equation was derived to explain the annealing rate of color centers in SAPG.

The results were controversial, and considerable discussion followed from the floor. Mr. Bishay, Argonne Laboratory, reported the discovery of a radiation-induced band associated with Pb, Tl, and Bi, and Mr. Bray, Brown University, described some magnetic resonance methods.

FRIDAY MORNING

High Temperature Glass Monofilament, by F. J. Hartwig and R. C. Young, Babcock and Wilcox Company, Alliance, Ohio. Presented by Mr. Hartwig. A method was devised for drawing continuous glass monofilaments of refractory compositions having melting points in the 3500°F temperature range. A description was given of the construction and operation of the melting furnace, using an inductively heated refractory metal crucible capable of temperatures up to 4000°F. Continuous monofilaments of 4 compositions: aluminum, calcium, magnesium, and titanium silicate were drawn, in diameters ranging from 100 microns down to 10 microns. Preliminary tests on one particular composition, an aluminum silicate glass, demonstrated that the fibers retain much of their strength after exposure to high temperatures.

Properties of Glass Fibers at Elevated Temperatures, by W. H. Otto, Owens-Corning Fiberglas Corporation, Newark, Ohio. This paper was not formally presented, but the following abstract is given. Measurements of tensile strength, modulus, and static fatigue were made on fibers of E-glass, Fiberglas X-37B glass and on those submitted by Imperial Glass Company (N-672 composition), General Electric Company (silica) and Bjorksten Laboratories (silica). The following summary compares the properties of these fibers at elevated temperatures.

The tensile strength of all fibers studied decreased as temperature increased above 75°F. The test data showed that fibers of the different compositions may be ranked in order of increasing service temperature:

1. Imperial N-672,
2. Fiberglas E-glass,
3. Fiberglas X-37B,
4. General Electric silica.

If the service temperature limit is defined as the temperature at which the tensile strength has decreased to 25 per cent of the strength measured at 75°F., the values for the four glasses follow:

1. N-672, 1050°F;
2. E-glass, 1240°F;
3. X-37B, 1360°F;
4. silica, 2000°F.

The tensile strength in dry air was generally 15 per cent higher than strengths measured in air at 50 per cent relative humidity.

Heat treatment increased both the yield stresses and modulus of elasticity of all fibers studied except silica. But since a high-temperature, low-density state is not quenched into the silica fiber in forming, thermal compaction effects cannot be expected. For fibers of the other three glasses, heat treatment generally increased the modulus 10 to 15 per cent.

For fibers of N-672, E-glass, and X-37B compositions stabilized by high temperature heat treatments, the modulus of elasticity decreased as the temperature increased. This decrease in modulus followed, in general, the thermal expansion of the glass, the change in modulus being greater for glasses having high coefficients of thermal expansion. However, the modulus of silica fibers

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Dry Compressed Air in Glass Manufacturing

COMPRESSED AIR is an important factor in the operation of most industrial plants, especially in the glass industry. Compressed air requires power; in fact, the glass container manufacturer's power bill for compressing air amounts to some 40 per cent of his total power bill.

It is essential, therefore, in the modern compressed air system, to have maximum thermal efficiency and capacity. There are several basic principles which must be considered.

1. Relationship between the temperature of the air and the air volume.
2. The amount of moisture in the air at atmospheric pressure and also the moisture at line pressure.
3. The operation of the air compressor itself.
4. The efficiency and operation of pneumatic equipment and tools.

Temperature and Volume

Up to the present time, not much interest has been given to the proper conditioning of the intake air to an air compressor, even though 20 years ago the *Compressed Air Magazine* published the following information in their Compressed Air Data Handbook:

"Wherever possible, the intake duct should be run to the outside of the building, preferably on the north or coolest side. Because of the fact that the average outdoor temperature is considerably below that of the engine room, there is scarcely a situation to be found where it does not pay to take the air from outdoors. An example will best show the economy of taking outdoor air.

"Irrespective of the outside temperature, the compressed air in a shop pipe line will closely approximate the temperature of the shop by the time it reaches the tools. Assume the indoor temperature to be 70°F. If the compressor takes in 1000 cubic feet of free air directly from the shop, it will also deliver 1000 cubic feet of free air at the tools, because the initial and final temperatures are the same.

"Suppose the outside air averages 40°F. If the compressor is supplied with intake air from outdoors, only 943.0 cu. ft. of free air will be required to deliver 1000 cu. ft. of free air at the indoor temperature, a direct saving of 5.7 per cent. The cooler the climate, the more pronounced the effect becomes.

"If the compressor is supplied with intake air from an engine room where the temperature is 100°F, 1057 cu. ft. of free air will be required to deliver 1000 cu. ft. of free air at the indoor temperature of 70°F.

"An actual case is recorded where, without a cold air intake duct 1,500,000 cu. ft. of free air delivered was costing $43.96 per day. After an intake duct leading outside was installed, this cost dropped to $40.42, an annual saving of $1062.00.

"Very appreciable savings such as this can be obtained with only the small expense of installing the intake duct. The effect of the intake temperature on the final delivery is shown in Table I."

Table I
EFFECT OF INTAKE TEMPERATURE ON CAPACITY
Intake Volume Required to Produce 1000 Cu. Ft. of Free Air at 70°F.

Temperature of Intake °F.	Relative Intake Volume Required In Cu. Ft.	% H.P. Saved
30	925	7.5
40	943	5.7
50	962	3.8
60	981	1.9
70	1000	0.0
80	1019	–1.9
90	1038	–3.8
100	1057	–5.7
110	1076	–7.6
120	1095	–9.5

According to *Kent's Mechanical Engineers' Handbook*, in a discussion on the effect of intake temperature on Efficiency and Capacity of Compressors, "The temperature of intake air, for economy, should be as low as possible. Hence, it is best taken, not from the warm engine room, but from outside of the building, preferably at a point shielded from direct rays of the sun and free from dust. For every 5°F lower temperature, the gain is approximately 1 per cent."

It is well known that during winter operation air compressors are more efficient than in the summer. A large Detroit manufacturer has found that if he has five identical air compressors in a single plant with approximately the same operation summer and winter, only four air compressors are needed in the winter. During the summer however, when the intake air temperature increases, the company *must* start the fifth air compressor in order to maintain the air line pressure.

If this manufacturer should install equipment to maintain winter temperature intake air for every hour of the year, he could expect from 18 to 20 per cent more air volume than he has been producing during summer operation. Although the temperature referred to in Table

I is used at approximately 70°F, there are many installations where a 90°F or 110°F line temperature could be used with no problem at all. Actually, in order to obtain the most capacity and the highest thermal efficiency, some automotive plants are now engineering their compressed air systems for operation at an air temperature of 125°F. They cannot afford to use air below this temperature because loss of air line temperature means loss of air volume, which is most expensive, not only in power costs but compressed air equipment costs.

According to a well-known manufacturer of after-coolers, if the temperature at the compressor outlet is about 275°F, and if there is no after-cooler, then the system temperature (due to radiation in the lines) will be 120°F.

In other words, because it is now economically possible to maintain a winter temperature of 38°F or less, day or night, in all seasons of the year at the air intake, the inlet air is sufficiently dried so that an after-cooler is not required, and the air temperature at the point of use can be 125°F. Because there is a difference in temperature between the air at point of use of 125°F and air at the intake of 38°F, the increase in air volume would be in excess of 17 per cent.

There is also an additional gain in volume. When moisture (water vapor) is removed before compression, it is obviously not necessary to compress that water vapor. The volume is reduced by the amount of water condensed, and there is an additional gain in air volume of 1 to 2 per cent, depending upon the amount of water vapor in the atmospheric air. It is therefore, easy to understand why there is an increase in air volume of from 18 to 20 per cent during winter operation.

A number of large companies which use compressed air in their operations have contacted various manufacturers of air compressors in order to obtain information on the capacity of their existing equipment. One of the leading air compressor manufacturers has suggested that a unit such as the Coblentz Dry Air System be used in conjunction with one 21″ x 21″ x 14″ Single Stage, Duplex, Water-Cooled Air Compressor, direct connected to a 350 HP, 277 RPM, Unity Power Factor Synchronous motor. Based on intake of 14.7 PSIA and 60°F, the above compressor would have a capacity of 3,370 CFM, measured at 225°F, if we were to have an intake temperature of 35°F.

Assuming that by using an over-size after-cooler, with an 80°F average inlet temperature, the 50 psig plant air supply was after-cooled to 80°F, the capacity of the above air compressor would then be rated at 2468 cfm. The loss due to after-shrinking the air would amount to (3370-2468) 902 cfm for the same compressor brake horse power. In this instance by using a Coblentz Dry Air System the volume gained is: $3370 \div 2468 = 1.365$. This is a gain in air volume of 36.5 per cent.

A standard cubic foot of air is normally taken at 14.7 psia or 30″ of mercury and 60°F. When the discharge pressure is 50 psig it requires 14.0 brake horse power per 100 cfm; this can be expressed as 7.14 cfm per brake horse power. These capacities are cubic feet of air per minute at inlet pressure and temperature, and must be corrected for actual operating conditions.

The Dry Air System can deliver refrigerated, dry, high-density air to the compressor intake at 35°F or less and a pressure blower can be used to maintain a sea level pressure of 30″ of mercury. With this process, heat of compression can be used to do useful work and the temperature at the point of use can be 225°F. This may be expressed as follows:

$$7.14 \times \frac{30}{29} \times \frac{685}{495} = 10.170 \text{ cfm/BHP}$$

Some glass container plants have been operating with insulated air lines for several years; the gain in air volume is from 8 to 13 per cent over an after-cooling system. Many conditions affect this volume gain, such as the temperature of the inlet air, the temperature of the compressed air at point of use, and the moisture in the air system.

All free air contains considerable moisture in the form of water vapor, and the amount varies according to the location and climatic conditions. Since vapor-carrying capacity is greatly reduced under pressure, water condenses in the piping system as soon as the air cools. The presence of water in a compressed air system has many harmful effects.

Moisture Content

Elimination of moisture in compressed air is best accomplished by refrigeration, according to one of the largest users of compressed air in the United States. When atmospheric air is 100 per cent saturated at 33°F, there are 0.3 pounds of water per 1000 cubic feet of (free) air entering the compressor. When the air is compressed to 50 pounds pressure, and the air-line temperature is 75°F, the 50-pound air line at this temperature will hold 0.3 pound of water per 1000 cubic feet of air. Therefore, as long as the 50 pound air line is above 75°F, there will be no further condensation inside the air line. When air is used at 125°F, at 50 pounds pressure, the relative humidity of the air under pressure is 25 per cent. Actually for every 20°F rise in temperature, the air will hold twice as much moisture.

There are many 50 psig installations, of course, where it is not required to have an extremely low dew point. Therefore, by refrigerating to 37°F dew point, the air, when compressed to 50 pounds pressure, will hold 0.35 pounds of water per 1000 cubic feet and will be dry at a temperature above 80°F. When this air is used at 200°F, at the point of use, the relative humidity of the 50-pound air will be less than 10 per cent saturated.

Air Compressor Equipment

In addition to the air volume advantage of supplying clean, dry, cold air at the intake to an air compressor, plus the advantage of having the atmospheric air pre-dried before compression, there are several other important advantages to be gained by refrigerating the intake air to a single-stage air compressor. When the air enters the single-stage air compressor at 38°F, dry bulb, or less all year round, the intake valves operate at a more uniform temperature and are not subject to the high summer conditions that usually occur in this country.

Because the air is pre-dried, there will be no con-

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G.C.M.I. Meeting

Left to right: Joseph C. Feagley, Armstrong Cork Co., and William J. Green, president, Thatcher Glass Mfg. Co., Inc.

Left to right: J. W. Thayer, Hazel-Atlas Glass Division, Continental Can Co.; V. L. Hall, general manager of GCMI; and M. H. Pickard, U.S. Borax and Chemical Corp.

● THE GLASS CONTAINER Manufacturers Institute held its semi-annual meeting at the Arizona Biltmore in Phoenix, Arizona, from November 9 through November 12. During the 3½-day session, committee reports were presented in order to bring the membership up to date on GCMI activities during the past 6 months.

Peter W. Hoguet, president of the Econometric Institute, predicted that glass container demand in 1960 would reach 160.2 million gross, or 3 per cent above the estimated 1959 shipments (156.0 million gross). Part of the increase was attributed to a rebuilding of glass container inventories by users, according to Mr. Hoguet, which was especially heavy in the third quarter of 1959.

Glass containers, said Mr. Hoguet, are gaining competitively in several major industries, especially in food where the growing use of glass packaging reflects in part an upward trend in consumer income. Specialty foods are showing a faster rate of growth than food items in general; persons in higher income brackets tend to be above-average consumers of these foods.

In the household and industrial chemical industry, the growing use of liquid detergents has helped boost glass container demand to the extent that shipments in 1959 are expected to be 17 per cent above those in 1958.

Another area which is gaining competitively is that of the non-returnable beer bottle. Mr. Hoguet pointed out that this growth may be accelerated next year by the promotional program now being carried on by the Glass Container Manufacturers Institute in conjunction with breweries in order to increase consumer acceptance of beer packaged in one-way bottles.

The Econometric Institute's forecasts of glass container

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Left to right: F. H. Wright, west coast manager of GCMI; F. N. Dundas, Dominion Glass Co., Ltd., and president of GCMI; and R. L. Cheney, executive director of GCMI.

Left to right: Bush Barnum, director of advertising for GCMI; F. B. Pollock, chairman of the board, Thatcher Glass Mfg. Co., Inc.; and J. P. Levis, chairman of the board, Owens-Illinois Glass Co.

CHRISTMAS

Glass Ornaments

by Frank J. Maietta
DESIGN DIRECTOR, MAX ECKARDT DIVISION,
ALLIED PAPER CORPORATION, NEW YORK, N. Y.

Machine-decorated ornaments. Design is around circumference only.

Imported hand-decorated ornaments. Design is limited only by imagination of artist.

• THROUGH THE AGES GLASS has been, and will continue to be, a symbol of grace and beauty. It is especially fitting that so many Christmas ornaments made of glass are used the world over in this Holiday season.

In selecting a design for a Christmas ornament, the practical side must first be considered, since there are two ways of applying the design to the glass surface—by hand and by machine. A design that is to be reproduced by machine must repeat itself so that it can be applied to the surface of a glass ball in a continuous, automatic operation.

Hand-Decorated Ornaments

A design which is to be applied by hand has no limits, except the time of the artist. In all cases, I continually keep in mind that simplicity is beauty, and the constant use of new materials and techniques should express the qualities and beauty inherent in them. Each material should be used in such a way that it fits the design naturally and is not made to portray something that it is not. In other words, when we use glass we always portray something light and majestic; it would be wrong to make glass look heavy. We use bright colors like green, red, and blue to help convey this feeling.

When an ornament is decorated by hand, several artists must work on the same ornament, because each man has his specialty. Stripes, dots, and stars, which appear for example on hand-painted glass balls are each applied by an artist, one at a time, in what is known in the trade as a labor pool.

In many cases, after the original design has been accepted and given to the labor pool to copy, it quite often comes back looking just a little different—the personality and technique of each artist is added, so that although the finished design resembles the original to some extent, actually no two hand-decorated ornaments are ever the same.

In many cases, the original hand-painted design is altered slightly so as to make it less expensive to produce in quantity.

Hand-decorated ornaments, made almost exclusively in Europe today, can always be picked out of a group, because they are either round or free form (blown), and the artist is allowed more freedom of expression than when he works with a machine-decorated ornament. There are few limitations as to what he can do with the many materials at his fingertips, like paints, jewels, glitter and paper.

Machine-Decorated Ornaments

These Christmas glass balls are made by the ribbon machine like the envelopes for electric light bulbs. They

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GLASS

Glass Figurines

by ***H. Bruckdorfer***
120 AVERY COURT, ST. LOUIS, MO.

• IN THE BOHEMIAN FOREST during the 19th century there were many fine glass manufacturing plants, or Glasshuettes. It was at one of these that I began my career in glass, particularly glass sculpting. The tooles, materials and methods of this almost forgotten art can readily be described; however, as in any creative process, it is imagination and skill which produces the delicate figures and objects from two glass rods.

My tools consist of a bench burner (using a gas and oxygen mixture which creates the hotter flame that is needed for working rods of especially hard glass); eyebrow tweezers; a larger pair of tweezers; and, if possible, glass rods made from my own formula.

If I use glass other than my own, I choose a good lime glass, being careful never to mix rods from different manufacturers during the forming of one glass article. The expansion of different glasses creates a stress that will break the article. Also, colored glass rods should never be mixed with clear rods until a test has been made to determine the results. Becoming familiar with the characteristics of the glass, and forming a mental picture of the figure to be created are among the most important steps. Once the figure has been started it cannot be erased.

A Swan

To make this figure I take two rods approximately sixteen inches long and ten millimeters in diameter. A rod is held in each hand. The rod in the right hand is heated until a ball is formed that is large enough for the swan's body. The body is taken out of the fire and replaced by the left rod. After the left rod is heated, it is attached to the body and both are again heated to form the tail. Now the right rod, which is still attached to the body is heated and pushed against the body, forming another ball; this ball is heated until soft enough to be pulled upwards and into the shape of a graceful neck. Once the neck is formed, the right rod is melted off, and the underside of the body is heated. The heated part of the body is then pressed down on a carbon block to form the base.

For the wings the right-hand rod is heated again and brushed along the side of the body from the neck towards the tail. When the desired length of the wing has been reached, the rod is melted off. This procedure is duplicated for the other wing. Now the swan's head can be made. To do this, the end of the neck is heated into a small ball and kept soft. If the correct temperature is maintained, a fine head will form. While the ball is being kept soft in the flame, a thin, yellow opaque rod is heated and fused to the head. The yellow rod it then pulled downward, making the beak. To create the eyes, white opaque is used; the pupils are made of black glass.

A wooden clothes peg is clamped to the head, and the left rod which formed the tail is melted off. It will take approximately twenty minutes before the swan can be handled with the bare hands.

A Stag

To create a stag, two rods are used, as they were in making the swan. This time the left rod is heated until a small ball forms. Keeping the ball on the left rod soft, I heat the right rod until a similar ball forms, and then press the two together. Fire is applied to the glass on the right rod which is then pulled in a direction away from the left rod. If the heat is applied at the right spot,

it will form a powerful thigh and slender hind leg. The thigh, which is still pliable, must be bent down and toward the left hand to form a 45 degree angle. Heat is applied where the thigh and the leg meet, and the leg is bent backwards parallel to the left rod and put into the fire again, one-half inch from where it was bent.

The leg is quite slender at this point, and caution must be used so as not to melt it off. Bend it to form a right angle with the left rod and melt it off at the correct length. After one hind leg is completed, the procedure is repeated for the other one.

The same rod is then used for the tail, but only a small amount of glass is needed here. Heat is applied at the point where the left rod joins the hind legs. Slowly turn the rod, move it to the right, and push the melting left rod together until enough glass has formed for the body; then melt off the rod. After the body is shaped by heating and turning, the rod with the tail is transferred to the left hand. A ball is formed on the rod in the right hand and fused at the front of the body. Each front leg is formed by pulling this rod downward and melting it off at the right length.

For the neck and head, I use an oblong ball of glass which is fused on top of the body near the front legs. The head is formed by heating and pulling the rod upward, bending it parallel to the body, heating it one-half inch away from the bend and pulling it. The eyes and nose are then made. A rod is heated and fused to the head; antlers are formed, and the stag is finished.

By forming the legs into different positions, also the neck and head, the stag will run, jump, or charge; and the eyes can be friendly or angry. Here, only one's imagination, art and skill can give the animal grace and expression.

A Tree

In making a tree ten to twelve inches high with birds sitting on three branches, I use a heat-resisting glass. Working this glass is very different from working lime glass; a very hot fire is needed. If the fire is not sufficiently hot, the object will be rough and lumpy. By fire polishing, the appearance of this glass under light is more brilliant than that of lime glass. Although the refractive index is only approximately 1.4 and lime glass is about 1.5, the heat-resisting glass has the advantage of low expansion, which makes it ideal for forming trees, flowers, pioneer wagons, and buildings.

I start with two rods, and make the birds first, the branches second and the tree trunk last. To make the bird, the rod in the right hand is heated until a round ball forms for the body. This ball is molded to the end of the rod in the left hand, drawn out to the shape of a pear, and burned off. To make the tail, the right rod is heated again and a small piece of glass is molded to the narrow end of the pear shape and pulled out at 45 degrees to a thin point. This is repeated in order to make a V-shaped tail.

For the head, the right rod is heated to a small ball which is molded to the thick end of the pear shape and pulled up parallel to the left rod where it is melted off, and the head is formed.

In the fire again, the right rod is heated to a ball and molded to the side of the body, burned off and reheated, squeezed and heated again; attached to the body and pulled toward the tail. Having repeated this on the other side, the wings are completed.

When the eyes and beak are attached, the bird is then completed. A wooden spring clothes peg is used to hold the bird by the tail while the left rod is burned off, leaving enough glass for it to be attached to the branch later on.

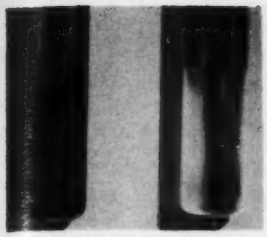
For the branch, two rods are again used, but each with different diameters. The thinner rod is held in the left hand and the thicker rod is molded to it—heated, pulled to a point, and burned off. This is repeated on the sides. This step completed, the birds are molded on.

Now for the leaves. A five-millimeter rod is heated until a ball forms. This ball is molded to the twigs, squeezed and pulled out to a point. Once all the leaves are completed, the branch is held by a clothes peg, and the left rod is burned off.

When the branches are finished, the last and most difficult part of the tree remains, the trunk. I use ten-millimeter rods and again start with two rods, forming the roots first. The left rod will be the trunk. The right rod is molded to the left and heated; they are pushed together to form a grotesque shape, or just pulled out and burned off. After all three roots have been completed, the left rod is switched to the right hand and the left hand holds the end of the coldest root. The rod for the trunk is heated and pushed together until it is almost one inch thick. This is repeated until it is high enough to support a branch.

The rod is burned off and the branch is carefully heated and fused to the trunk. The fusing must be thorough or the branch will break off later. Once the branch is straightened out, I mold the burned-off rod to the trunk and repeat the heating and pushing together of the rod. Although I choose the grotesque shape of the tree, out of hundreds, no two will look alike.

The length of time involved in making a figure varies, depending on the figure itself and on its size. It may require from ten minutes to one hundred hours. For instance, making a scene of palm trees and flamingoes, all in colored glass, is not so easy. The flamingoes' thin legs and long necks make them most difficult to balance. On my first try, every flamingo broke, until I found out which part had to be made first. Sometimes the figure must be designed on paper before I can work in glass. It is necessary to have a first-class knowledge of glass, and the glass rod must be free of silica seeds, large air inclusions and stress. If these are present, the waste may cause a shortage of glass in the midst of working on an article. Small gas inclusions may make big ones, and the whole article might break after completion. One should wear glasses to prevent hot splinters from flying into the eyes.



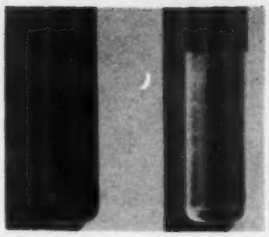


Fig. 1 (left). Alkali test samples. Fig. 2 (right). Acid test samples. In each illustration new glass appears on left.

New Corrosion-Resistant Glass

• AMONG THE INTERESTING products exhibited at the 27th Exposition of Chemical Industries at the New York Coliseum, November 30 to December 4, was a new corrosion-resistant glass introduced by Glascote Products (subsidiary of A. O. Smith) of Cleveland, Ohio.

Called 778, it is the most corrosive resistant glass applied to steel that has ever been developed, declares S. R. Stout, A. O. Smith sales manager, and has shown greater resistance to sulfuric, nitric and hydrochloric acids, and at the same time, good resistance to thermal shock. It will permit up to a 75°F increase in acidic reactor operating temperatures.

Although the glass becomes dull after a short time in a corrosive medium, and appears corroded, it shows very little weight loss.

Abrasion properties for this glass are the same as for other glasses; the inherent anti-sticking properties have not been sacrificed. If thermal shock limits are exceeded, no spalling will result.

In an acid corrosion test, (10 per cent hydrochloric acid for 16 hours at 350°F) the new glass lost 1.142 milligrams per square inch, compared to a loss of 1.875 milligrams per square inch for laboratory glass.

In an alkali test, (0.5 per cent solution of sodium hydroxide for one week at 200°F) the glass displayed

In an alkali test (0.5 per cent solution of sodium hydroxide for one week at 200°F), the glass displayed a material loss of 14 milligrams per square inch as compared with 70 milligrams per square inch with a borosilicate glass.

Although laboratory glass shattered at 350°F when quenched in 50°F cold water, "778" did not spall under identical conditions with a 310°F temperature differential.

The new glass is being used for lining such products as reactors, vessels, columns, storage tanks, rotary dryer-blenders and coating agitators.

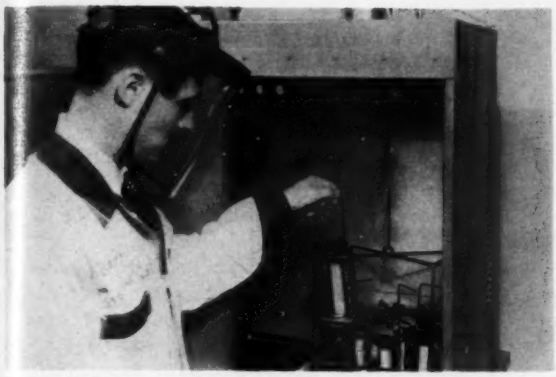


Fig. 3. Technician inserting test bombs used in oil bath under high pressure for checking corrosion of glass.

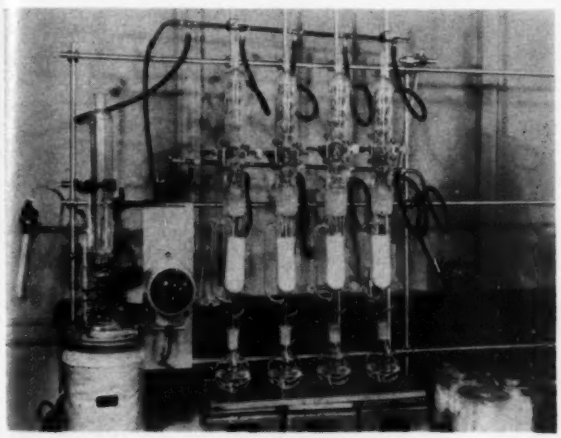


Fig. 4. Extractor setup for surface finish evaluation.

Fig. 5. Another early test stage for new glass. Small porcelain balls in ball mill break the various frit formulations down into a gritty liquid—the slip.

Fig. 6. The slip is sprayed on metal. After drying, it is moved to kiln where it is fired.

Nickel and Cobalt Films *by Samuel Wein,* CONSULTANT

Part Three

● THE NICKEL FILM must be dried immediately after deposition, according to West, otherwise discoloration will occur. West's technique is to rinse the pieces, after they have been nickeled, for one minute in cold water. and then in denatured alcohol and finally allow them to air dry.

Pessel, a Research Chemist with RCA, patented the following series of formulas:

Example 1

	Parts
Nickel acetate (1%)	10
Sodium hypophosphite (Sat. Solut.)	1
Hydrazine hydrate (85%)	1

Here we have two reducing agents. Pessel finds that if two drops of a 0.1 per cent palladium chloride solution is added to this solution, an intensive reaction occurs at room temperature. A film of nickel is formed on the glass surface having an electrical resistance of 300 ohms between two points 1 cm. apart.

If, however, the hydrazine is left out, the reaction is much slower at room temperatures. If the sodium hypophosphite is left out of the mixture, leaving only the hydrazine hydrate and the palladium chloride to react with the nickel acetate, no reaction or film formation takes place at room temperature after 10 minutes.

Nickel acetate works better than nickel chloride, and the latter better than the sulphate. Nickel formate also works much better.

Example 2

	Parts
Nickel acetate (1% Solut.)	10
Sodium hypophosphite (Sat. Solut.)	1
Hydrazine hydrate (85% Solut.)	1
Methanol	3

Example 3

	Parts
Nickel acetate (1% Solut.)	10
Sodium hypophosphite (Sat. Solut.)	1
Hydrazine hydrate (85% Solut.)	1
Sorbitan* monolaurate polyexalkylene derivite (2% of total)	

*A wetting agent made by Atlas Powder Co.

A nickel citrate solution containing sodium formate as developed by Pessel consists of:

Example 4

	Parts
Nickel citrate (1% Solut.)	10
Sodium formate (Sat. Solut.)	1
Sodium hypophosphite (Sat. Solut.)	1
Hydrazine hydrate (85% Solut.)	1

A typical nickel formate formulation consists of:

Example 5

Nickel formate (1% Solut.)	70 cc.
Sodium hypophosphite (50% Solut.)	7 cc.
Hydrazine sulphate (85% Solut.)	7 cc.
Palladium chloride (0.1% Solut.)	28 drops

Previous to the making of the above solution, the nickel formate solution had been cooled to 10° C.

Nickel films were formed on sheets of ethyl cellulose steeped into the solution for 10 minutes. Similar results were had with a sheet of polystyrene previously coated with a 5 per cent toluol solution ethyl cellulose.

Other nickel formate solutions consist of:

Example 6

	Parts
Nickel formate (1% Solut.)	10
Sodium hypophosphite (Sat. Solut.)	1
Hydrazine hydrate (85%)	1

Example 7

	Parts
Nickel formate	10
Ammonium hydroxide (conc.)	1
Sodium hypophosphite (Sat. Solut.)	1
Hydrazine hydrate (85%)	1

Example 8

	Parts
Nickel formate (1% Solut.)	10
Hydrazine hydrate (85% Solut.)	1
Sodium hypophosphite (Sat. Solut.)	1
Benzyltrimethyl ammonium hydroxide* (42% Solut.)	1

*A wetting agent made by Rohm & Haas Co.

The following solution, developed by Girard, gives rise to a bright, smooth nickel deposit which is characterized by its hardness and adherent properties with practically no stress. The solution is made up of:

	Grams 1 Liter
Nickel sulphate	80
Sodium hypophosphite	24
Sodium citrate	12
Boric acid	8
Ammonium chloride	6

The preferred temperature is between 196 and 204° F. The optimum pH is from 4.6 to 5.0. Dullness and roughness resulting from a pH above 6.0 or below 4.0 is to be avoided.

The ten-gallon solution accredited to West is made up of:

Nickel chloride	5 pounds
Sodium citrate	8 "
Sodium hypophosphite	1 pound

Professor Hackerman adds Pyridine to the solution:

	Grams 1 Liter
Nickel chloride	50
Ammonium chloride	50
Ammonium hydroxide	100 cc.
Sodium hypophosphite	100
Pyridine	20 cc.

The solution was maintained at 90° C., preferably by steam since electric heat provided excessively hot spots which caused precipitation of powdered nickel. The deposited nickel was uniform, smooth and adherent.

Gutzeit and Lee adds propionic acid to the foregoing solution:

	Moles Liter
Nickel sulphate	0.07
Sodium hypophosphite	0.23
Propionic acid	0.03
Lactic acid	0.30

Talmey, Metheny and Lee patents:

	Moles 1 Liter
Nickel chloride	0.0675
Sodium succinate	0.06
Malic acid	0.06
Lactic acid	0.2025

The use of sodium succinate with sodium acetate is described by Gutzeit, Crehan and Krieg. A typical solution formulation patented by Talmey and Gutzeit is

Example 1

	Moles 1 Liter
Nickel hypophosphite	0.09
Sodium hypophosphite	0.045
Sodium chloride	0.18
Sodium succinate	0.06

The pH is adjusted to 4.6 with hydrochloric acid.

Example 2

	Moles 1 Liter
Nickel hypophosphite	0.09
Sodium hypophosphite	0.045
Sodium chloride	0.18
Malic acid	0.18
Sodium succinate	0.06

The pH is adjusted to 4.6 with sodium hydroxide and hydrochloric acid.

Glycine as a chelating compound for use with nickel is described by Talmey and Gutzeit in which their solution is made up of:

	Moles 1 Liter
Nickel hypophosphite	0.09
Sodium hypophosphite	0.45
Sodium chloride	0.18
Glycine	0.18

The pH of the solution is to be adjusted to 4.60 with either sodium hydroxide and hydrochloric acid.

Methany and Talmey add malic acid to the glycine combination using:

Example 1

	Moles 1 Liter
Nickel sulphate	0.07
Sodium hypophosphite	0.23
Malic acid	0.135
Glycine	0.07

The pH is 6.3 and adjusted with sodium hydroxide or with sulphuric acid.

Example 2

	Moles 1 Liter
Nickel sulphate	0.07
Sodium hypophosphite	0.23
Glycine	0.21

The pH is 6.3 and adjusted with sodium hydroxide or sulphuric acid.

A one shot dilute solution of sodium acetate with nickel acetate according to Jendrzynski and Stapelton, which turns green to colorless, indicating complete depletion of the nickel consists of:

	Grams 1 Liter
Nickel acetate	16.7
Sodium acetate	20.0

Sweo's version of the acetate solution consists of:

	Grams 1 Liter
Nickel chloride	30
Sodium hypophosphite	10
Sodium acetate	10

Dr. Narcus says his solution "gives the most consistent results" with the addition of brighteners which is optional (5 c. c. of Harshaw compound #XXX44 or 3 c. c. of XXX20) may be employed with fair results. The actual nickel solution is made up of:

	Grams
Nickel sulphate	35
Sodium citrate	10
Sodium acetate	10
Sodium hypophosphite	15
Magnesium sulphate	20
Duponal C (1% by weight of solution)	10 cc.
Water	1000 cc.

This solution deposits approximately 0.0005 inch of nickel per hour and is said to be less susceptible to decomposition.

Spaulding added glycollic acid (70 per cent) to his version of the nickel solution which consisted of:

	Grams 1 Liter
Nickel chloride	30
Sodium hypophosphite	10
Glycollic acid (70%)	35
Sodium hydroxide	15

Bolin left out the sodium hydroxide from his version of the solution, for instance:

	Grams 1 Liter
Nickel chloride	30
Sodium hypophosphite	10
Glycollic acid (70%)	40

The use of lactic acid is described by Gutzeit and Lee:

	Moles 1 Liter
Nickel sulphate	0.08
Lactic acid	0.30
Sodium hypophosphite	0.23

The initial pH of this bath was adjusted to 4.50 with sodium hydroxide.

Other contributions using lactic acid with other chelating compounds are (Metheny and Talmey):

(*Continued on page* 726)

TEN Years of Progress in the Glass Industry (*Continued*)

by H. E. Simpson
STATE UNIVERSITY OF NEW YORK COLLEGE OF CERAMICS
ALFRED UNIVERSITY, ALFRED, N. Y.

Because glass is so important to the ELECTRONICS INDUSTRY, we are presenting a survey of that industry's progress during the past few years. This is a continuation of the Ten-Year Review in Glass by Dr. Simpson which we published last month.

INDUSTRIAL PRODUCTS

Industrial electronics established a record $1.38 billion factory sales mark in 1958, exceeding the 1957 total by $80 million.

Industrial electronic devices sort, control, test, measure, and count such items as mold plastics and metal products; they find flaws in textiles, and solve problems for engineers and scientists. The industrial market has doubled during the past five years, now representing 18 per cent of the industry.

Analog and digital computers, arithmetic and logical units, comparators, data recorders, information storage devices and tape recorders are the "electronic brain" which read, write, compare, make yes or no choices, and transfer information from one place to another more accurately than their human counterparts.

Nearly 2,000 of these units are installed in more than 1,200 companies. Several hundred others are in use by government agencies and the armed forces. At the end of 1958, 3,000 were on order at prices ranging from $300,000 to $2,000,000 each.

Testing and Measuring Equipment

Electronic testing and measuring equipment is essential for temperature assessment in high frequency heating applications, analysis of chemical properties, detection of plywood separation and measurement of cross-section extrusion.

Ranking second to computers in share of the industrial market, sales of testing and measuring devices reached $280 million in 1958, an increase of $10 million over 1957. Densimeters, electronic timers, microwave testers, spectrometers, and voltage calibrators are used by every major U. S. industry. Ultrasonic instruments are important tools in processing certain metal, glass and insulating materials. Automotive analyzers simulate driving conditions and pin-point vibrations.

Industrial Controls

Sometimes referred to as "automation", this area of industrial electronics depends on counters and sorters, automatic control and dielectric heating equipment, infrared, remote controls, etc.

Automation is the technique of improving human productivity in the processing of materials, energy and information by utilizing in various degrees elements of self-control and of automatically executed product programming.

Electronic gear guides machinery along a given pattern determined by tape, record, or tracing and feeds back the actual performance to the control unit which automatically makes corrections.

Factory sales of industrial control devices climbed to

FACTORY SALES TO THE INDUSTRIAL MARKET
(In millions of Dollars)

Type of Equipment	1954	1955	1956	1957	1958
Computers and Processing	$ 47.0	$ 72.0	$125.0	$ 265.0	$ 290.0
Testing and Measuring	110.0	145.0	170.0	210.0	220.0
Navigational Aids	60.0	65.0	70.0	95.0	100.0
Landmobile—Microwave—Broadcasting	90.0	95.0	120.0	150.0	155.0
Industrial Controls			115.0	150.0	160.0
Nuclear-Electronic Apparatus			22.0	27.0	35.0
Medical and Therapeutic	343.0	373.0	110.0	139.0	145.0
Commercial Sound			110.0	136.0	140.0
Communication			30.0	36.0	40.0
Miscellaneous			78.0	92.0	95.0
Total	$650.0	$750.0	$950.0	$1,300.0	$1,380.0

$160 million in 1958 and $150 million in 1957 and $115 million in 1956.

Nuclear-Electronic Apparatus

The growth of nuclear electronics, which includes such items as geiger counters, reactor controls and dosimeters depends on the sale of radioactive isotopes to industrial, medical, and research firms. Currently, there are more than 4,000 licensed isotope users plus an undetermined number operating under general agreements.

In the medical field, where one million persons have been treated or diagnosed through the use of radioactive isotopes, annual instrument sales are approaching a four million dollar level. During 1959, the industry anticipates a growing demand for cancer therapy units and diagnostic tracer equipment.

Sales of nuclear-electronic apparatus registered the largest percentage increase during 1958, up 30 per cent from 1957 sales of $27 million.

Medical and Therapeutic Equipment

In addition to nuclear-electronic apparatus, medical electronics includes cardiograph, diathermy and gamma ray radiographic equipment, and X-ray devices. Encephalographs, electrocardiographs, myographs, electronic heart stimulators and automatic anesthesia devices have become standard diagnostic tools. Sanquinometers analyze blood samples, radioactive arsenic locates tumors; ultra-violet light illuminates cells under a microscope and radioactive pills make pressure readings.

This phase of the medical and therapeutic field reached $145 million in 1958 compared with 1957's $139 million market.

Landmobile, Microwave and Broadcast Equipment

Landmobile radios serve agriculture, mining, heavy construction, and engineering activities. In industry "two-way" radios find wide application within banks and insurance companies. Investment firms use them for communication with field appraisers. Requirements of taxi cabs, buses and other transportation facilities ensure steadily growing markets for mobile radios.

Microwave systems supplement mobile radios in highway and turnpike toll collection and communication functions. The trucking industry has expressed its need for equipment to promote more efficient operation. Traffic signal and automatic speed control systems increasingly depend on microwave techniques.

Education has been the primary market for closed circuit TV as indicated by the increasing number of educational television stations. Starting with two in 1953, seven additional stations were added during 1954, nine in 1955; four in 1956; six during 1957; and seven in 1958. Today, 35 stations annually spend $375,000 delivering instruction to 75,000 classroom receivers.

Sales of landmobile, microwave and broadcast equipment totaled $155 million in 1958.

Navigational aids

The market for air and ground traffic control equipment, autopilots, shoran systems, radio range equipment, etc., continues upward. During 1958, sales of navigational aids reached $100 million, up $5 million from 1957 and sixty-seven per cent more than 1954's total of $60 million.

Navigational equipment has become an indispensable component in the complex job of determining a plane's true course, speed and location. Electronic altimeters use radio signals for determining the altitude. Recent developments enable ground systems to monitor all aircraft within a 120-mile range, up to an altitude of 60,000 feet.

Communications Equipment

The constant rise in communications sales can be attributed partly to the increased complexity of the typical airliner. Ten years ago an airplane carried $12,000 worth of electronic gear composed in large part of communication devices. Today, the comparable aircraft has standard electronic equipment valued at $98,000. In the future, the jet airliner will require more numerous and complex communications systems.

Communications equipment sales reached the $40 billion mark in 1958, up $4 million from 1957.

Miscellaneous Equipment

Sales of other electronic equipment such as automotive direction and speed controls, meteorological equipment and photoelectric devices reached $95 million during 1958.

Telemetering systems, which permit direct observation of space, unhampered by intervening atmosphere, have become vitally important in the transmission and reception of data from missiles and space vehicles.

The following table shows the sales of industrial electronic equipment for the years 1954 through 1958 in millions of dollars.

TELEVISION PRODUCTION

Year	Table Portable	Console	Phono-Comb.	Total	Value (000 omitted)
1947	116,315	37,039	25,217	178,571	$ 50,000
1948	646,509	179,181	149,310	975,000	230,000
1949	1,792,691	989,220	218,809	3,000,000	580,000
1950	2,941,560	3,820,060	702,180	7,463,800	1,350,000
1951	2,275,901	2,744,859	334,038	5,384,798	956,986
1952	2,837,507	3,038,895	219,878	6,096,280	1,049,000
1953	3,224,724	3,755,340	235,763	7,215,827	1,230,298
7954	4,249,339	3,011,536	85,840	7,346,715	1,028,540
1955	4,439,676	3,199,796	117,049	7,756,521	1,071,020
1956	4,753,787	2,556,845	75,397	7,387,029	938,596
1957	3,845,807	2,433,449	120,089	6,399,345	832,747
1958	2,716,876	2,068,627	134,925	4,920,428	$ 667,899

CONSUMER PRODUCTS

Factory billing of television receivers totaled $686 million during 1958, down $145 million from 1957. Factory sales of radios decreased from $350 million to $326 million. Although phonograph unit sales were off by 20 per cent, the dollar value of factory sales rose to $263 million from $248 million in 1957, and $146 million in 1956.

During 1958, new products began to win consumer acceptance; more than 55,000 electronic organs were sold by factories, together with electronic garage door openers, kitchen devices and other products. The 1958 market was estimated at $66 million compared to $40 million for 1957.

Radios

The number of radios has nearly doubled since 1949, with some 143 million in operation today, of which 47 million are car radios.

Nearly 81 per cent of the 3.4 million portable radios produced in 1958 contained transistors—up significantly from 50 per cent during 1957. The transistorized clock radio was introduced in 1958, and transistorized table models found growing popularity.

Japanese radio imports increased greatly in 1958 exceeding two million units by the year's end compared with 641,000 units the previous year.

Retail sales of home clock and portable models, excluding Japanese radios, totaled 8.0 million units during 1958. Portable radios increased in per cent of total, while home radios decreased.

Nearly 100 new F. M. stations were authorized during 1958. Of these, 34 began broadcasting to bring the "on the air" total to 571. The number of AM's increased 138 to an all-time high of 3,318.

That year also witnessed the start of stereo broadcasting. Signals are sent out via two channels using either an FM or an AM station, two separate FM stations, or one AM station and TV's FM audio signal. Still in the experimental stage and requiring special reception equipment or adaptors, the technique called "multiplexing" offers a fourth method whereby both signals can be sent simultaneously over FM or over AM.

Television

At the year's end, 463 VHF and 83 UHF television broadcasting stations were sending signals to 50 million receivers in 86 per cent of the nation's 51 million homes. This represents a significant increase from 46 million TV's in operation at the end of 1957 in 83 per cent of 50 million homes.

Sales of televisions as a replacement and as a second or third receiver are increasing. Consumers have shown continuing interest in the portable models which entered the market four years ago. Export sales reached a record high last year, totaling 206,000 units, compared to 140,418 in 1957 and 110,089 in 1955.

Production of monochrome TV in 1958 totaled 4.9 million units, or 23 per cent less than 1957's 6.4 million, and 37 per cent less than 1955's all-time high of 7.8 million units.

MILITARY PRODUCTS

Sale of electronic products for military uses comprised 52 per cent of total industry sales during the calendar year 1958. This market increased $200 million over the 1957 level, reaching $4.1 billion.

Aircraft Electronics

The most important feature of aircraft procurement is the shift in emphasis to new weapons. All fighters and bombers included in the fiscal 1959 Air Force procurement list are capable of supersonic speeds and are able to carry missiles and nuclear weapons. Only a few of the model types that were standard during 1955 are currently being purchased by the Air Force. Similarly, of the $1.5 billion of aircraft engines and aeronautical equipment the Navy is buying during fiscal 1959, about 80 per cent will go for models which were not produced in quantity during fiscal 1955. Currently, more than 40 per cent of the Army's total procurement is for missiles (and related gear) compared with only 10 per cent in fiscal 1955.

The fiscal 1960 budget includes funds for 1,610 aircraft—703 for the Air Force, 668 for the Navy, and 239 for the Army—or about 150 less than fiscal 1959's procurement. Purchase of B-52 and B-58 strategic jet bombers and KC-135 jet tankers is to be greater during fiscal 1960 than during fiscal 1959. Fighter bombers are to be purchased in fewer numbers by the Air Force. No funds are allotted for interceptors. The Navy will buy a greater number of fighters during fiscal 1960 and a smaller number of attack aircraft. The Army will require more high-performance turbo-prop observation aircraft and fewer helicopters.

(*Continued on page* 723)

RADIO PRODUCTION
(000 omitted)

Year	Home	Clock	Portable	Auto	Total	Value
1946	13,276		1,069	1,610	15,955	$434,244
1947	14,083		2,458	3,459	20,000	650,000
1948	9,630		2, 30	4,240	16,500	525,000
1949	5,961		1,843	3,596	11,400	310,000
1950	7,053		1,675	4,740	13,468	346,128
1951	5,275	777	1,333	4,543	11,928	298,439
1952	3,539	1,929	1,720	3,243	10,431	238,348
1953	3,886	2,041	1,742	5,183	12,852	286,471
1954	2,696	1,875	1,333	4,124	10,028	220,616
1955	2,998	2,244	2,027	6,864	14,133	283,225
1956	3,037	2,311	3,113	5,057	13,518	288,474
1957	3,228	2,516	3,265	5,496	14,505	351,601
1958	2,621	2,038	3,373	3,715	11,747	$304,116

NEW PRODUCTS (*Continued*)

Photochemical Glass

This is an opaque glass of special composition that is cut by a new process, "chemical machining," producing without the aid of mechanical tools lace-like patterns hitherto considered impossible in glass. To the ultraviolet ray exposure and subsequent heat treatment has been added a third step in the process—immersion in an acid bath which etches out desired areas. Research indicates that this method of machining glass will have many uses in the fields of electronics, lighting, and photoengraving.

The method consists of forming in the glass itself a 3-dimensional photographic image, then dissolving it with dilute hydrofluoric acid. The rate of solution of the exposed sections, after development, is some 50 times faster than that of adjacent unexposed glass. Such a process makes it possible to machine glass with photographic precision and detail by a method adapted to mass production. Pieces can be produced which are so intricate that their manufacture by mechanical processes would be impractical or impossible. The new glass is the latest in a series of photosensitive compositions first announced in 1947.

A special composition glass is used in this chemical machining process. The glass is made photosensitive by the presence of trace quantities of compounds of silver, gold, or copper together with a sensitizer. In the photographic process, successive treatments with actinic radiation and heat form submicroscopic metal particles as nuclei in the glass. With further heat treatment, the metal particles induce crystallization of some of the constituents of the glass.

The resultant crystalline areas in the glass contain lithium silicate crystals which are readily dissolved by hydrofluoric acid, while adjacent vitreous regions are relatively resistant to attack.

The first step in the process, the printing of a design in the glass, is accomplished, as in previous photosensitive glasses, by placing an ordinary photographic negative on a piece of the new photosensitive glass and exposing it to ultraviolet rays. The exposed glass, still clear is then placed in an oven and heated at approximately 1200° F. for the required length of time, usually one hour. At this stage, a milk-white image appears in the otherwise transparent glass, the heat treatment having brought out the latent image developed in the glass, through the ultraviolet exposure.

The glass with the milk-white image is immersed in a solution of hydrofluoric acid until the white areas are eaten through and removed, leaving the remaining unexposed glass as the exact complement of the original pattern.

By varying the length and intensity of light exposure through the photographic negative, the operator can accurately control the depth of acid penetration into the glass from shallow etching to complete erosion. In this way, sculptured figures or contoured shapes can be made by using a continuous tone negative with proper degrees of shading. Since chemical machining involves no mechanical stress, patterns otherwise too complex to reproduce in glass or any other material without long and tedious work by skilled craftsmen can be simultaneously reproduced in any number, and with photographic accuracy.

The process is applied in drilling multiple holes, which can be complex in shape and precise in spacing and dimensions; in cutting out small or irregular shapes; and in photoengraving. Its advantage over other photoengraving methods is that the necessity for a protective surface coating is eliminated. Patterns photoengraved by this process can be filled with conducting materials to form electrical circuits of high precision and durability. All these operations (drilling, cutting and photoengraving) can be preformed simultaneously in one or many pieces of glass.

Metallized-Glass Printed Circuit Boards

Metallized-glass printed circuit boards for high-temperature applications under high humidity conditions are being made of Fotoceram. Because they can withstand a continuous operating temperature of 500° C., and their electrical resistivity is very good, they are especially suitable for missile applications.

A Glass Pipeline of Light

A new and improved type of fluorescent lighting has been applied to traffic tunnels. A recently opened tunnel utilizes 3,000 twelve-foot sections of glass piping. Inside each section are two 6-foot slim line fluorescent lamps placed end to end. A threaded metal cap screws on the threaded end of each section of piping. After the lamps have been placed inside, the metal cap, in turn makes contact with the supporting fixture on the tunnel ceiling.

Glass Pipe

Glass pipe owes its wide acceptance in the manufacturing and process industries to its unique properties and dependable performance. The new "Double-Tough" pipe further enlarges the field of application through increased strength.

Its transparency permits constant visual inspection of sedimentation, crystallization, or discoloration of liquids. The surface of the glass is microscopically smoother than any other process piping. Build-up of scale or other surface deposits is prevented, and cleaning is easier. Indication of its excellent chemical stability and high heat resistance may be obtained from the following data:

(*Continued on page* 728)

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NEWS in The Glass Industry

Richard MacPherson

J. B. Holschlag

New Fiberglas Textile Plant for Owens-Corning

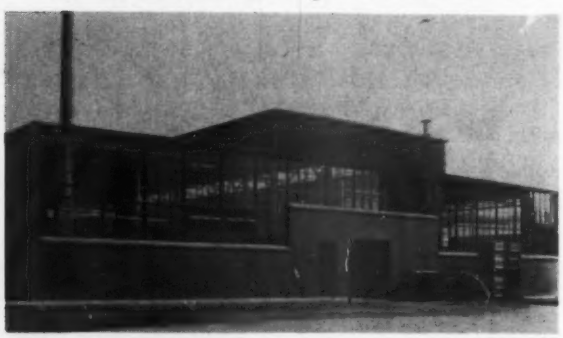
Owens-Corning Fiberglas Corporation is beginning construction on a multi-million-dollar Fiberglas textile yarns plant in Aiken, S.C., which will be equipped with the most advanced processing facilities for fibrous glass textile materials. To be located on a 350-acre site three miles east of Aiken, the new plant is expected to be completed by the third quarter of next year, and initial production of the first units has been scheduled for next June.

Richard MacPherson, formerly production superintendent of the Barrington, N. J., plant, will be manager of the new facility.

Jerry B. Holschlag, formerly manager of the company's Ashton, R. I., plant, will be project engineer.

The new Aiken plant will provide added Fiberglas yarn production for the company's three textile plants located in Anderson, S. C., Huntingdon, Pa., and Ashton, R. I.

Owens-Corning has five other plants which are located in Newark, Ohio; Kansas City, Kan.; Santa Clara, Calif.; and Barrington and Berlin, N. J.



Pemco Corp. color building for manufacture of inorganic pigments. The 30,000 sq. ft. structure contains a mezzanine for overhead loading of grinding mills. Capacity of the company's color manufacturing department has been doubled.

Harbison-Carborundum Corp. Formed

Harbison-Walker Refractories Company and the Carborundum Company have established a jointly owned subsidiary for the engineering, manufacture and sale of fused refractories. The new firm, Harbison-Carborundum, will be owned on a 50-50 basis and will produce fused refractory lines of alumina, chromite and zirconia base refractories for the glass industry.

O-I Offers Bubbler Patent Information

Owens-Illinois Glass Company has accumulated technical information in extended studies on the use of bubblers to improve the quality and flow of the glass batch in a continuous melting tank. This information is available to any interested container manufacturer.

Anchor Hocking Glass Corporation has been the first manufacturer to receive the rights to use the patents. The contract formed between the two companies will serve as a basis for other container manufacturers.

Under the contract the container manufacturer is granted a license under all Owens-Illinois patents relating to the recommended installation with the option to extend use of bubblers to all of its other furnaces. Owens-Illinois will also furnish recommendations for installations of bubblers in any desired furnace, plus drawings relating to all necessary components of the recommended bubbler installation. The company will also furnish the personal services of an engineer to provide advice and consultation concerning installation techniques and procedures for operating bubblers to achieve optimum improvement in glass quality and furnace pull.

The bubbler installations introduce gaseous bubbles of controlled size at certain critical areas along the bottom of the glass tank with the objective of increasing the pull of the glass tank and reducing stones, seeds and cord in the melted glass. The result is an improved batch distribution and properly controlled convection currents in the molten glass.

Dr. Tsuchihashi Joins Stanford Research

Dr. Shoji Tsuchihashi of Japan has joined Stanford Research Institute as a visiting research scientist to conduct advanced investigations in glass technology.

Dr. Tsuchihashi is a specialist in the surface chemistry of glass and a professor of chemistry at Kobe University, Japan.

He will do basic and applied research on the physical chemistry of glass in the physical and inorganic chemistry section.

Barnard Resigns as J-M Fiber Glass President

Randolph H. Barnard has resigned as president of Johns-Manville Fiber Glass Inc., a manufacturing subsidiary of Johns-Manville Corporation, with headquarters in Toledo. He will continue to advise Johns-Manville as a consultant on fiber glass.

Francis H. May, Jr., vice president and general manager of the company's Fiber Glass Division, now has full responsibility for administration. He has spent his entire business life in glass manufacturing and has been closely associated with Mr. Barnard for more than 10 years. Both men joined Johns-Manville in December, 1958, when that firm acquired the former L.O.F Glass Fibers Company.

Mr. Barnard has been associated with the glass business for 37 years and during the early 1930's was one of the pioneers in a series of industrial research projects that resulted in developing and merchandising fibrous glass.

He was with Owens-Illinois Glass Company for 22 years where he became executive vice president and a director. In 1944, he left to organize Glass Fibers, Inc. which merged with L.O.F Glass Fibers Company in 1955.

Mr. May began his glass career with Owens-Illinois in 1940 as manager of its War Contracts Division. In 1946, he joined Glass Fibers, Inc., as vice president and secretary, assuming the additional responsibility of treasurer in 1948. He retained these responsibilities when the company was merged with L.O.F Glass Fibers Company in 1955.

He became a vice president and director of Johns-Manville Fiber Glass Inc. when the company acquired the business in 1958.

Gayner Joins Brockway

Louis Gayner has joined the Brockway Glass Company as administrative assistant of the manufacturing division. He has been associated with the glass container industry over twenty-five years and was an originator and trustee of the Glass Container Manufacturers Institute, and past president of that organization.

PPG Market Research Assignments

Pittsburgh Plate Glass Company has made a series of divisional market research assignments in the company's marketing research department.

Thomas F. Mitchell is responsible for marketing research in the flat glass field and Thomas R. Aberant will handle the market research functions in paint sales. Norman F. Heydinger is responsible for departmental operations in the fiber glass field.

Wallace Vice President at O-I

Robert T. Wallace, assistant director of research, has been appointed vice president of the Panamanian subsidiary of Owens-Illinois Glass Company's International Division, Owens-Illinois International, S.A. He will be concerned with new foreign investments and licensing and technical agreements in the Western Hemisphere.

Randolph H. Barnard

Francis H. May, Jr.

Libbey Program Cited

A program that doubled sales of non-institutional tableware for the Libbey Glass Division of Owens-Illinois Glass Company, from 1954 to 1958 was cited by the Association of National Advertisers "for outstanding marketing success."

Bert Herron, director of advertising for Owens-Illinois, accepted the citation at the Association of National Advertisers' annual meeting in Hot Springs, Va., and presented a history of the Libbey success story. In 1954 he explained statistics indicated the tableware market was saturated and the company could increase its sales only by taking from another company. However it was found that the consumer was not aware that the market was saturated. To the housewife-consumer the only over-riding fact was that the glassware had to have appeal.

In order to use this appeal to full advantage the company completed a major restyling of the Libbey line and began pre-testing the sale of all proposed retail designs through actual exposure in the market place. To complement the new styles, Libbey doubled the amount of money spent on promotion. Mr. Herron pointed out that the new Libbey styles brought a general upgrading of the entire line.

Hensler in Bausch & Lomb Executive Post

Dr. J. R. Hensler has been appointed head of the glass technology department of the Chemical Research Laboratories, Bausch & Lomb Optical Company.

R. T. Wallace

Dr. J. R. Hensler

Frank Moore

J. F. Knight

Moore Joins Drakenfeld

Frank Moore has joined the technical staff of B.F. Drakenfeld & Company. He will be assigned to Drakenfeld's technical service staff after completion of a special training program at the company's Washington, Pa., plant and research center.

Norman Retires From O-I

Nolde A. Norman has retired as branch manager of Owens-Illinois Glass Company's Indianapolis branch. He has been with the company since 1912 and with the Indianapolis branch since 1926.

Walsh Appoints Charbonnier

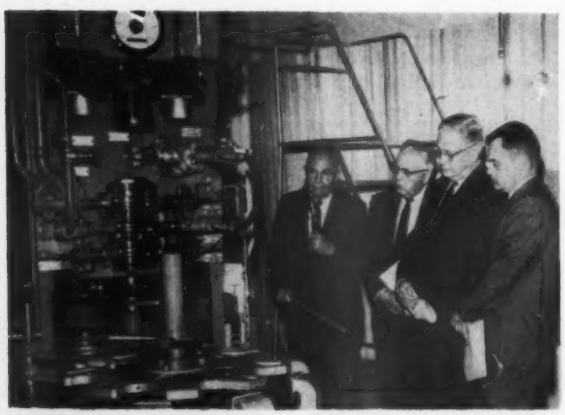
W. P. Charbonnier has been appointed technical assistant to the vice president and sales manager of the Glass Refractories Division of Walsh Refractories Corporation.

He has had over 20 years' experience in glass industry refractories including both the slip cast and fused cast methods.

Foote Names Regional Sales Managers

Foote Mineral Company has appointed John D. Clark and Douglass S. Collins as eastern and southern regional sales managers, respectively.

Mr. Clark, formerly manager of ceramic sales, will maintain his office at Germantown, Pa., and Mr. Collins will remain at Knoxville, Tenn.



C. F. Claughsey, Emhart Mfg. Co.; explains the operation of the new Type R-7 glass forming machine, distributed by Emhart, to, left to right, Fred Foust and Gordon Herrold, Anchor-Hocking Glass Corp.; and George Ruck, Continental Can Co., Hazel-Atlas Glass Div.

Knight Manager at Kaiser

Joseph F. Knight has been appointed manager of operations for the Kaiser Refractories & Chemicals Division. He will be responsible for the administration of the division's manufacturing facilities in the U.S. This includes plants in Natividad and Moss Landing, Calif.; Columbiana, O.; Midland, Mich.; Mexico, Mo.; Frostburgh, Md.; Niles, O.; and Van Dyke, Pa.

Dr. Sun Completes Fulbright Professorship

Dr. K. H. Sun, head of the Westinghouse Radiation and Nucleonics laboratory, has returned from Taiwan (Formosa) where he completed a Fulbright Professorship at Tsin-Hua University, serving as visiting professor and acting director of the Institute of Nuclear Science.

At the Institute Dr. Sun taught an intermediate course in nuclear physics, directed the research work of twelve graduate students and supervised the calibration of a 3-MEV Van de Graaff accelerator, installation of a one-megawatt swimming-pool research reactor, and the design and building of a large Radioisotope Laboratory (including a 1000 curie γ-ray hot cell) and a Nuclear Engineering Laboratory. He also aided the development of a new type of glass containing an unusually high amount of uranimum and a novel photographic scheme for neutrons.

Inspecting the new glass forming machine are, left to right, J. E. Crouse, Emhart Mfg. Co.; J. McBurney, Owens-Illinois Glass Co.; A. Buffone (front), Brockway Glass Co.; T. Tinmouth, Iroquois Glass, Ltd.; L. Bruno, Brockway Glass Co.; C. G. Kemp Consumers Glass Co., Ltd.; C. F. Claughsey, Emhart Mfg. Co.; Al Hayes, Armstrong Cork Co.; J. Bowles, Brockway Glass Co.; W. W. Pedrick, Armstrong Cork Co.; R. Simonton, American Thermos Products Co.

Emhart Displays New Machine

Emhart Manufacturing Company gave the first U.S. viewing of the Type R-7 glass forming machine which they will distribute for the Belgium manufacturer, Ateliers J. Hanrez. Representatives of glass container manufacturers from the U.S. and Canada saw the special display of the machine and the Emhart equipment with which the R-7 was designed to function.

The R-7 will produce narrow neck glassware from the beer bottle size to half-gallon jugs. Production rates can be as high as 60 containers per minute depending on bottle size. The company stated that their studies have shown that 22 per cent of all the glass containers made in this country could be produced more economically with the new machine.

F. T. Cantrill

O. F. Runde

J. L. Black

John A. Dickinson

Owens-Illinois Appointments

Frank T. Cantrill, manager of sales, has been named manager of the Owens-Illinois Glass Company's glass container division branch in Detroit. He has been with the company since 1946.

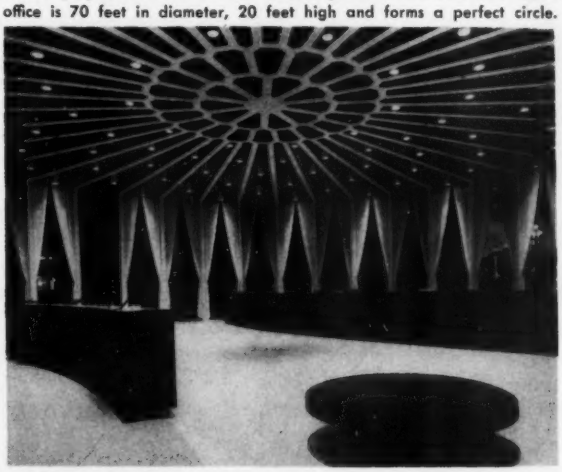
Oliver F. Runde and James L. Black, have been appointed manager and special assistant to the general factories manager, respectively, of the Owens-Illinois Glass Company's glass container plant at Fairmont, W. Va.

Mr. Runde joined the company in 1937 as an industrial engineer and Mr. Black has been with the organization for 35 years.

American Smelting Expands Output

American Smelting and Refining Company has installed new facilities at its Central Research laboratories that are expected to triple the company's capacity of high purity (99.999 per cent) arsenic production. The arsenic is used as a component of special low melting glasses and in semi-conductor compounds.

American Trust Company's new office in the 20-story glass and mosaic Crown Zellerbach Building, San Francisco, Calif. Entire wall area is quarter-inch polished plate glass in lancet-shaped panes measuring five feet in width, 17 feet in height at the outer edges, and 18 feet in height at the pointed center. Panes are set into 40 nine-degree bays. Extruded sponge neoprene cushions inside anodized aluminum frames support glass on all sides. Neoprene is 50 per cent larger than normal to provide extra cushioning for storm and earthquake movement and to prevent structural loads from impinging on glass. Two-part polysulfide polymer sealant is used to seal panes inside and out. Bank office is 70 feet in diameter, 20 feet high and forms a perfect circle.



Dickinson Retires from N.B.S.

John A. Dickinson retired September 30 as Chief of the Codes and Safety Standards Section, National Bureau of Standards, after 40 years of service. During his distinguished career he has worked in all areas of safety, from the inspection and identification of unsafe areas in industry to the development of national safety standards and codes.

Earlier this year he received the Arthur Williams Memorial Award from the American Museum of Safety for "most outstanding achievement . . . in the interest of greater and improved industrial and general safety."

Mr. Dickinson joined the Bureau in 1919 as a safety engineer and was made assistant chief of the Codes and Specifications Division in 1941. When this became the Codes and Safety Standards Section in 1947, he continued as assistant chief until 1955 when he assumed his latest position.

Hommel Appoints Smith

Loran F. Smith sales-service engineer of O. Hommel Co. since 1955, has been appointed manager of the company's West Coast district.

Strandberg Named at Porter

Howard Strandberg has been named New York district sales manager for the Refractories Division of H. K. Porter Company, Inc. He was formerly executive vice president in charge of operations for Seaboard Refractories Company.

Feldspar To Build Flotation Plant

The Feldspar Corporation will construct a modern feldspar flotation plant in Middletown, Conn., which is expected to be in production early next fall. The plant will cost approximately one million dollars and will process both glass- and pottery-grade feldspar.

Buechner to Speak at Antiques Forum

Thomas S. Buechner, director of the Corning Museum of Glass will discuss Great American Glass, during the 12th Annual Williamsburg Antiques Forum to be held in Williamsburg, Va., January 25-29 and February 1-5. The five day sessions of the Forum will carry the theme of Great Antiques in American Museums.

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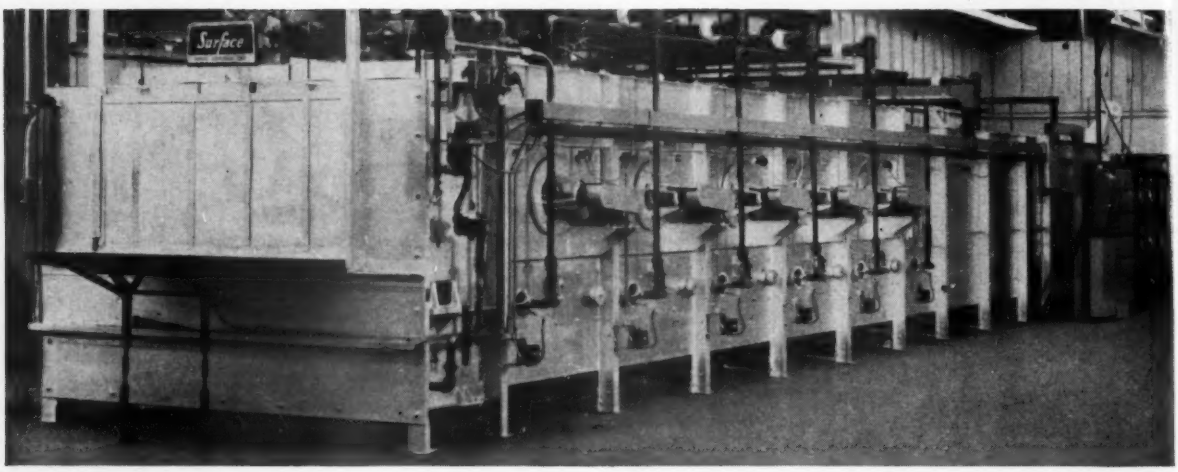
The Surface modular lehr offers a final solution to the company which wants to replace obsolete equipment, but dreads the excessive engineering costs of new units.

This lehr is really a series of standardized modules, which can be linked together to reproduce any prescribed temperature curve. This type of design saves you money because it spreads the engineering costs over many modules, and makes assembly fast and economical.

This lehr has many other features. In many cases, it makes replacement more profitable than retaining outmoded equipment. Please let us tell you more about it.



The new Surface modular lehr, annealing television tubes.

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wherever heat is used in industry

Surface

D. B. Lupton

Lupton with Chas. Taylor

Dale B. Lupton, formerly with the Corhart Refractories Company, Louisville, Ky., has joined the Chas. Taylor Sons Company, as a ceramic engineer in the research and development department.

Glass Insulation in Sun Oil's New R&D Laboratory

Sun Oil Company has installed a cellular glass insulation material in two testing chambers of its expanded $2-million research and development laboratory at the Marcus Hook, Pa., refinery.

Used for the controlled testing of oils and gasoline under conditions closely simulating outdoor driving, the chambers are subjected to rapid changes in temperatures ranging from –20°F to +125°F.

O-I Sponsors Fellowship

Owens-Illinois Glass Company is sponsoring a senior post-doctoral research fellowship at the University of Cambridge, England. It will provide $4,500 a year in stipend and materials for each of three years.

The research fellow will devote his time to research in one of three possible areas: friction of glass against metal at elevated temperatures, crystallization phenomenon at glass surfaces, or changes in surface structures due to changing environment of the glass sample. The Cambridge fellowship joins two other projects sponsored by Owens-Illinois in England; one is at the Fulmer Research Institute at Stoke Poges and the other, at the University of Sheffield.

Rush Skyscraper Construction

A crew of 25 glaziers is rushing to enclose a 40-story New York City skyscraper with 800,000 pounds of glass before the frigid temperatures and heavy winds of late December arrive.

The building will be encased in 270,000 square feet of glass including some 8000 sections of Libbey-Owens-Ford opaque spandrel glass for the between-the-floors areas, and approximately 10,000 pieces of Graylite for The Pittsburgh Plate Glass exterior picture window and three-pane sash window frames. Each of the more than 18,000 pieces of glass has its own particular predetermined place in the 40-floor framework and none of them are interchangeable.

$2,700,000 Expansion at Ferro

Ferro Corporation's Fiber Glass Division in Nashville, Tenn., will begin a $2,700,000 expansion program designed to alleviate the critical shortage of fiber glass reinforcing materials in the plastics industry.

The new program will include an additional glass smelting tank, fiber-producing bushings, fabricating machines and warehouse area. It will begin upon completion of the current $700,000 plant expansion and is expected to increase the company's fiber glass-producing capacity by 75 per cent when it is finished in late 1960.

Smith Joins Pemco

Howard J. Smith has joined the Pemco Corporation as assistant to the vice president. He has specialized in research in inorganic chemistry, including high temperature phenomenon and materials, catalysis and catalyst promoters, ceramics, including electronic applications and high temperature super refractories, piezoelectric devices and high temperature alloys and metals.

Dr. Baak Joins O-I Research

Dr. Tryggve Baak, physical chemist and recently an associate professor of silicate science at the University of Toledo, has joined the fundamental research section of Owens-Illinois Glass Company's General Research Department. He will conduct research work in the physical chemistry of the process of glass melting and refining.

Alternating rows of opaque spandrel and clear window glass which in late November covered first twelve floors of a 30-story Manhattan skyscraper. The one-million sq. ft. building must be completely encased in glass before late December because of weather.

... GLASS DECORATING — 1960 ...

CAMBRIDGE METAL-MESH BELTS are the answer to the big problems you'll face in the competitive '60's—tighter operating costs, higher production and consistent quality.

To cut belt repairs and replacements, Cambridge Belts are designed to resist distortion and travel straighter. Advanced manufacturing techniques give you a rugged belt that has greater strength to take faster speeds, heavier loads and higher temperatures.

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Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications

INVENTIONS AND INVENTORS

Annealing and Tempering

Method of fusing metal to glass articles. Patent No. 2,897,583. Filed October 15, 1956. Issued August 4, 1959. No sheets of drawings; none reproduced. Assigned to Networks Electronic Corporation, by Mikai D. Patrichi.

This invention relates to the art of joining metal to glass. Its general object is to provide an improved method of fusing metal to glass so as to obtain a hermetically sealed joint. The invention is useful in the fabrication of electrical components such as resistors, induction coils, condensers, electron discharge tubes, incandescent lamps, etc.

In the step of applying the initial metal coating to the glass, the preferred method is to apply a suspension of powdered noble metal particles in a liquid such as toluene that is evaporated away in the fusing step, leaving a molecular film of noble metal fused to the glass. In the next step, wherein additional metal is electrodeposited on the molecular film, a metal (such as copper) that will provide a good base for the subsequent soldering of the coating to a metal such as Kovar, is used. In the final step of joining the parts there is developed a solder film that securely joins the copper coating to the metal part.

The connection thus provided is hermetically tight, possesses great strength, and shows no sign of weakness over the extreme temperature range of minus 65 degrees F. to plus 500 degrees F. or more.

There were 4 claims and the following references cited in this patent.

United States Patents

2,075,477, Smith, Mar. 30, 1937; 2,335,376, Ballintine et al., Nov. 30, 1943; 2,379,635, Hastings, July 3, 1945; 2,490,776, Braunsdorff, Dec. 13, 1949; 2,527,587, Smyth, Oct. 31, 1950; 2,708,787, Chich et al., May 24, 1955.

Feeding and Forming

Apparatus for drawing sheet glass. Patent No. 2,896,376. Filed August 8, 1957. Issued July 28, 1959. No sheets of drawings; none reproduced. Assigned to American Window Glass Co., by Albert S. Crandon, Jr.

The present invention eliminates irregularities in glass drawing by providing a forced transverse flow of the ambient air in the drawing pit adjacent the meniscus of a rising sheet from each edge to the oppose edge and in mutally opposite directions of flow across the faces of the rising sheet so as to constantly recirculate air in a path closing on itself. The injection of additional gas or air into that path or into the pit generally, is not only unnecessary but undesirable and the steady current of ambient air thus produced stays well mixed without hot or cold streaks. It results in a fairly high but equalized temperature condition of ambient gas completely around the sheet with a consequently stable atmospheric pressure and equalized transfer of heat from the glass to that gas. In addition to minimizing the conditions causing distortion, it is able thus to reduce and equalize the initial permanent strain imparted to the glass as the glass sets and can accordingly provide improved annealing and relatively fast drawing speeds without excessive breakage in the machine or attendant breakage of the sheets in the storage rack.

There were 9 claims and the following references cited in this patent.

United States Patents

2,158,669, Amsler, May 16, 1939; 2,458,040, Weller, Jan. 4, 1949.

Furnaces

Method and Apparatus for Controlling Convection Currents of Molten Glass. Patent No. 2,890,548. Filed September 27, 1956. Issued June 16, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Joseph W. Wright.

By introducing a constant pressure flow of gas into the viscous glass body through a series of bubbling tubes, the gas forms bubbles of a given size which, when they break off from the bubbling tube, rise vertically in the glass body at a rate proportional to the size of the bubble formed. This upward movement of bubbles causes the viscous glass which envelopes them to move upwardly in the glass body with the bubbles, thereby causing an increased circulation of molten glass in their path. The continuous bubbling of gas in this manner produces a steram of comparatively small bubbles, their size depending primarily upon the viscosity of glass, the diameter of the tube and the pressure of the gas utilized.

Although the continuous flow of gas may be regulated to increase or decrease the number of bubbles formed per unit of time, the size of the bubble is substantially constant for a given viscosity of glass and given quantity of gas flow through the bubbling tube.

The rate of movement of the glass will vary porportionally to the size of the bubble. The rate of ascension to the point of degassing (bursting) of gas bubbles in a glass body is proportional to the surface area presented by the bubbles in contact with the glass. Since the surface area is directly proportional to the square of the radius while the ascension time is inversely proportional thereto, it follows that the rate of movement of a gas bubble toward its degassing action must be dependent on its

radius. This, however, holds true only under given conditions of glass temperature, the initial size of the bubble, and the expandability of the gas utilized. Variation in these later mentioned variable factors will also affect the degassing rate of the bubble. Generally the smaller the size of the bubble, the more closely the bubbler tubes must be spaced in any selected zone of the melter, and the more bubblers that will be needed to produce sufficient increased circulation of glass in that zone.

There were 17 claims and the following references cited in this patent.

United States Patents

2,263,549, Peyches, Nov. 18, 1941; 2,387,222, Wright, Oct. 16, 1945; 2,634,555, Henry et al., Apr. 14, 1953.

Glass compositions. Patent No. 2,883,292. Filed May 23, 1957. Issued April 21, 1959. No sheets of drawings; none reproduced. Assigned to Servo Corporation of America by Joseph Jerger, Jr.

This invention relates to glasses produced from ternary mixtures of the elements arsenic, sulfur and tellurium.

Examples of good glasses are as follows:

Designation	Percent AS	Percent S	Percent Te
a	55	40	5
b	50	35	15
X	40	40	20
c	45	30	25
d	20	40	40
e	20	35	45
f	15	40	45
g	15	60	25

The transmission properties are improved by the addition of tellurium and makes available a whole new group of compositions characterized by an improved combination of optical properties. If tellurium is added to replace part of the sulfur, the proportion of weight of sulfur can be reduced to as low a figure as about 25 per cent without devitrification of the melt. Also, the proportion by weight of arsenic can be reduced to substantially 13 per cent without devitrification. The sulfur will range from about 25 per cent to 78 per cent by weight and the arsenic from about 13 per cent to 56 per cent by weight.

There were two claims and the following reference cited in this patent.

United States Patents

1,917,725, Lenander, July 11, 1933.

Glass and Wool Fiber

Method and apparatus for bending glass sheets or plates. Patent No. 2,886,922. Filed February 3, 1955. Issued May 19, 1959. No sheets of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Company by Steve Yando, Jr.

This invention is generally concerned with the bending of glass sheets or plates, and more particularly with an improved method and apparatus for bending glass sheets of substantial length.

The automobile windshields now in common use, such as the panoramic or hook-type windshields, require the use of flat glass sheets of increased lengths as compared to prior windshields of relatively shallow curvature.

It provides a method of bending glass sheets in which the sheet to be bent is initially supported upon and bent into conformity with a convex shaping surface, after which the upper surface of the bent sheet is engaged by a concave shaping surface which conforms substantially thereto. The bent sheet is then inverted while retained between the two shaping surfaces so that it is supported upon the concave shaping surface, and the sheet is then annealed or tempered while supported on the concave shaping surface. In such a method, initial bending of the sheet takes place upon the convex shaping surface while the sheet is shaped to its finished curvature upon the concave shaping surface.

United States Patents

1,595,139, Blount, Aug. 10, 1926; 1,779,435, Kaier, Oct. 28, 1930; 2,104,673, Rieser, Jan. 4, 1938; 2,131,873, Goodwillie, Oct. 4, 1938; 2,526,359, Jendrisak, Oct. 17, 1950; 2,551,311, Batchell, May 1, 1951; 2,570,309, Black, Oct. 9, 1951; 2,620,174, Passafaro, Dec. 2, 1952.

Sheet and Plate Glass

Plants for grinding and polishing flat glass. Patent No. 2,883,801. Filed July 25, 1955. Issued April 28, 1959. No sheets of drawings; none reproduced. By Paul Dryon.

This invention relates to the grinding and polishing of flat glass and concerns the plants used for this purpose of the type comprising tables or supports on which the glass sheets or plate-glass are sealed and which are carried along a path hereafter called working path.

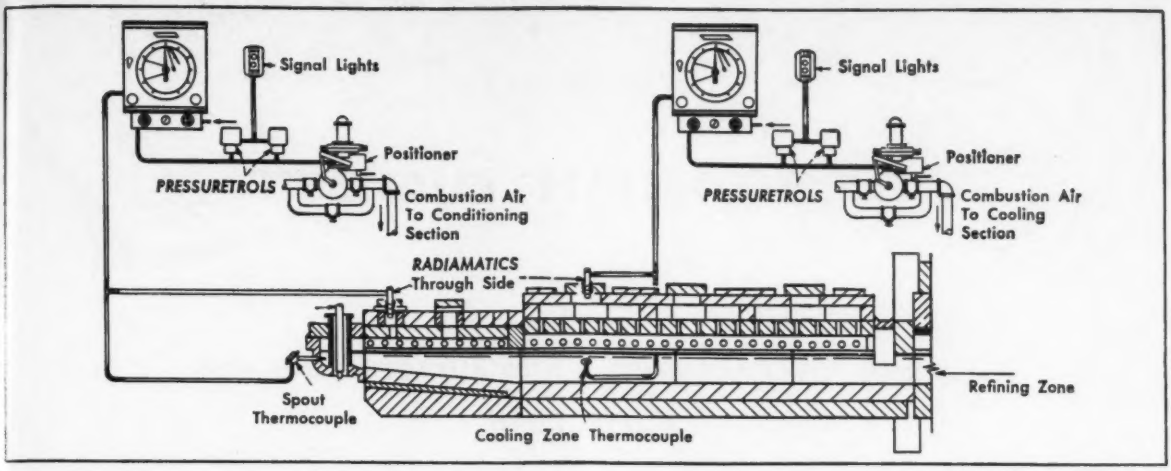
The transfers of the sheets of glass during grinding and polishing are performed in a series of successive elementary movements and each of such movements comprises an initial acceleration period and a final deceleration period and may be preceded (or followed) by a period of rest; use is made of the periods of slow or reduced and, or zero speed of the elementary movements for causing another table or support to partake to each of said transfers and thus carry it from one path to the other as well as to move a table or support which has reached one of the said paths away from the location in which it has been brought and cause said table or support to commence its travel on the working path or on the return path. Meantime the speed of "rotation" of the tables or supports is accelerated.

A table or support which has completed its transfer movement to reach the working path, is carried away from the location in which it has been brought by means of an initially accelerated and subsequently slowed down motion timed with a period of slow or reduced and, or zero speed of the transfer movement, the last period of the said eloigning motion being effected with the aid of a resilient force.

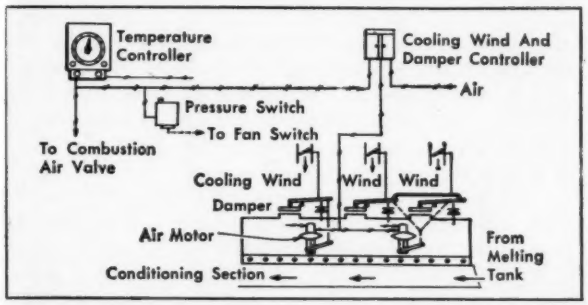
There were 15 claims and the following references cited in this patent.

United States Patents

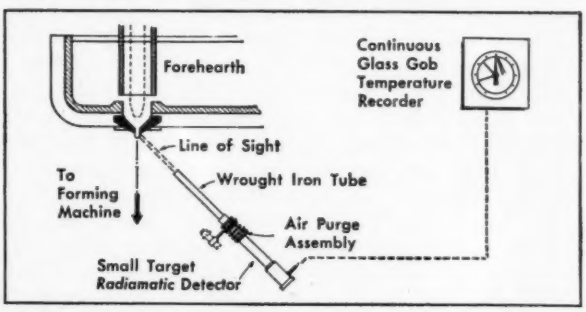
1,554,804, Fox, Sept. 2, 1925; 1,819,017, Drake, Aug. 18, 1931; 1,861,659, Fox, June 7, 1932; 2,186,854, Auger et al, Jan. 9, 1940; 2,546,914, Wheeler, Mar. 27, 1951; 2,569,393, Walker, Sept. 25, 1951.



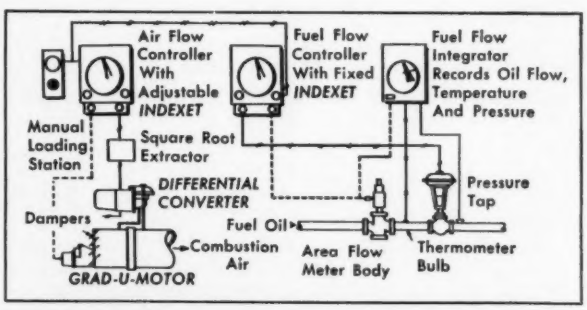
PNEUMATIC OR ELECTRIC FOREHEARTH CONTROL—assures precise glassware weight, higher machine speeds and larger gross packs. For electric control, Brown *Electr-O-Volt* control unit and electric actuators. For pneumatic control, Brown *Air-O-Line* control unit and pneumatic actuators. Sensing elements are either thermocouples or *Radiamatic* radiation pyrometers as desired.



COOLING WIND CONTROL—provides accurate, automatic control of both heat and cooling wind for higher machine speeds and larger gross pack, more uniform forehearth temperature, less fuel consumption.



CONTINUOUS GLASS GOB TEMPERATURE MEASUREMENT—provides continuous record and indication of actual gob temperature.



MELTING UNIT INSTRUMENTATION—keeps glass quality uniform; saves fuel; increases furnace life by precise control of fuel, combustion atmosphere, furnace pressure, and temperature. Engineered automatic reversal helps achieve and maintain peak efficiency.

Complete glass plant instrumentation developed for you by Honeywell...

These four control systems were developed by Honeywell, and are manufacturing better glass products more economically. What they do for others, they can do for you.

Honeywell, first to apply automatic control to the making of glass, has pioneered new techniques of measurement and control. For the future, it has built a unique body of experience and know-how to continue to meet the industry's expanding needs.

Ask your nearby Honeywell field engineer to help you gain the advantages of complete glass plant instrumentation. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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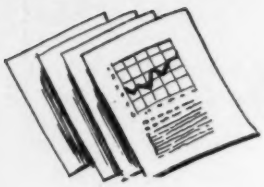
H HONEYWELL First in Control



RESEARCH DIGEST

Fourth International Glass Congress Papers Paris 1956

The papers presented before the Fourth International Glass Congress held in Paris, France during 1956 have recently appeared as a bound volume. Abstracts of several of the papers dealing with the practical side of glass melting are given below.

1. *Gas Components in Molten Glass in a Fourcault Tank Furnace,* by T. Okamura and S. Uemera.

In spite of the importance of refining glass in an actual operation, very few fundamental researches on this subject have been published. In order to obtain a clear picture of the mechanism of the refining process it is essential to examine the composition of the gas dissolved in the glass as well as of those contained in the bubbles. The authors have developed a method for the quantitative gas analysis and have carried out a fundamental experiment on pot melting, which was followed by several experiments on the refining process in actual Fourcault tank furnace operations.

The results revealed the following facts:

Although the glass in the cooling zone of a Fourcault tank is already sufficiently refined from the viewpoint of dissolved gases, the homogenization of glasses is still not satisfactory in spite of the enormous capacity of the tank. Consequently, the gases in the bubbles vary considerably at different sampling times. SO_2 bubbles constitute the main reason for the increase in the number of bubbles. These results furnished a valuable hint for actual tank furnace operations, and by summing up the experimental results obtained from the glass collected at different times from the tank furnace and by utilizing also the results of the experiments made on the melting of glass in a pot, there may emerge some information which will reduce the difficulty of securing an efficient and proper refining of glass in any type of tank furnace.

2. *The Volatization of Molten Glass,* by A. Dietzel and L. Merker.

The losses of batch as dust and by evaporation during the melting of glass are of great importance in the manufacturing of glass, being closely connected with the quality of the glass and the working conditions of the tank furnace. Formerly the opinion was generally held that the heavy deposition of alkali in the checker-work is mainly due to the loss of fine particles of batch. Recently, J. Loffler carried out investigations in a glass works with the aim of distinguishing between loss of dust and loss of evaporation and to indicate the influence of the preparation and handling of the batch on the loss of dust. According to his results, the ratio of loss as dust to loss by evaporation is about 16 to 84. That the alkali in the checkerwork is due mainly to evaporation losses is also confirmed by the observation that in a tank furnace mainly working with cullet, the depositions in the checker were not marked less than in a tank operating with batch. Consequently, the different preparation and handling methods of the batch have relatively little influence on the loss of alkali during glass melting in a tank.

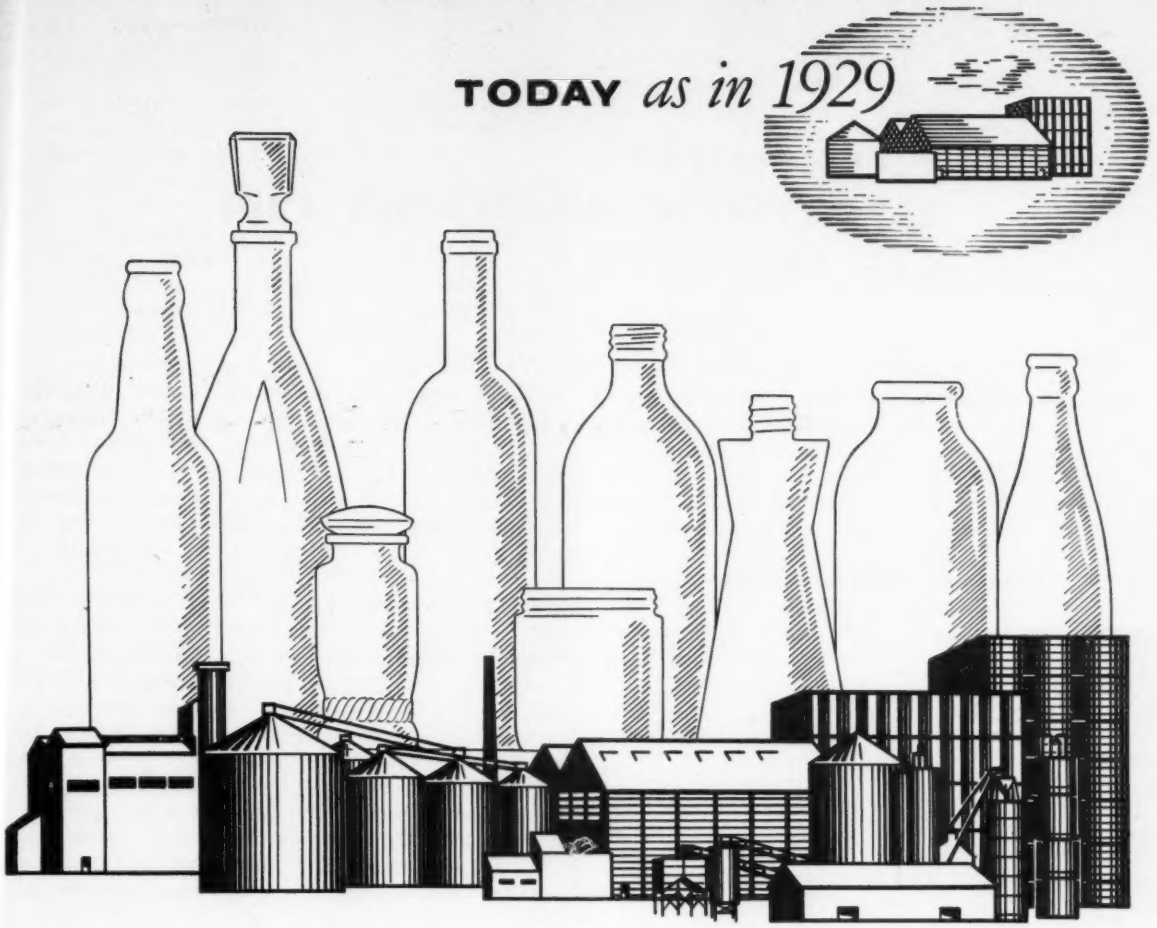
The authors have also studied the same problem, basing their investigations on those of W. E. S. Turner and co-workers, on the evaporation from glass. They first investigated the influence of the furnace atmosphere, especially the water vapor content. These experiments, carried out in a ceramic tube, showed that the evaporation losses are strongly correlated with the water vapor content, especially in the region of lower partial pressures of water vapor. A change in the rate of flow of the water vapor containing gas had (within certain limits) no marked influence. On the other hand, the type of material surrounding the glass sample has a great influence on the rate of evaporation. The maximum amount of evaporation was observed in the ceramic tube, so reducing the partial pressure of the alkali. Experiments with a platinum-tube of equal size showed that under the same conditions the rates of evaporation are only half as high in the ceramic tube.

The evaporation components (not only alkali, but also silica and lime) have to be determined analytically. By comparison with the glass composition it is hoped to gain some insight into the conditions governing the bonding of the constituents of the glass.

3. *The Melting of Homogeneous Glass,* by L. F. Oldfield and J. H. Partridge.

The differential thermal analysis of both simple and complex glass batches confirm the theory that the initial glass-melting reactions are solid and liquid-solid interactions leading to the formation of simple eutectic mixtures. In Na_2CO_3—SiO_2 mixtures reaction proceeds by the consecutive formation of Na_2O—$2SiO_2$ and Na_2O·

(*Continued on page* 727)



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CURRENT STATISTICAL POSITION OF GLASS

Employment in the glass industry during September, 1959, was as follows: *Flat Glass*: a preliminary figure of 30,400 for September, 1959, indicates an increase of 1.6 per cent over the adjusted figure of 29,900 reported for August, 1959. *Glass and Glassware, Pressed and Blown*: an increase of 0.4 per cent is shown by the preliminary figure of 87,800 reported for September, 1959, when compared with the adjusted figure of 87,400 reported for August, 1959. *Glass Products Made of Purchased Glass*: the preliminary figure of 15,500 given for September, 1959, is an increase of 3.3 per cent over the adjusted figure of 15,000 reported for August, 1959.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	October, 1959
Food	1,037,000
Medicinal and Health Supplies	1,570,000
Chemical, Household and Industrial	974,000
Toiletries and Cosmetics	885,000
Beverage, Returnable	531,000
Beverage, Non-returnable	95,000
Beer, Returnable	61,000
Beer, Non-returnable	777,000
Liquor	1,016,000
Wine	386,000
Sub-total (Narrow)	7,332,000

Wide Mouth Containers

Food	*3,491,000
Medicinal and Health Supplies	455,000
Chemical, Household and Industrial	137,000
Toiletries and Cosmetics	260,000
Packers' Tumblers	29,000
Dairy Products	172,000
Sub-total (Wide)	*4,544,000
Total Domestic	11,876,000
Export Shipments	216,000
TOTAL SHIPMENTS	*12,092,000

* This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production October 1959	Stocks October 1959
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,903,000	5,534,000
	Wide Mouth	*4,910,000	*5,418,000
Beverage, Returnable		753,000	1,679,000
Beverage, Non-returnable		106,000	215,000
Beer, Returnable		148,000	372,000
Beer, Non-returnable		868,000	597,000
Liquor		1,151,000	1,100,000
Wine		387,000	481,000
Packers' Tumblers		46,000	111,000
Dairy Products		178,000	219,000
TOTAL		*13,450,000	*15,726,000

* This figure includes Fruit Jars and Jelly Glasses.

Payrolls in the glass industry during September, 1959, were as follows: *Flat Glass*: An increase of 5.3 per cent is shown in the preliminary $17,159,650.59 given for September, 1959, when compared with August's $16,293,050.59. *Glass and Glassware, Pressed and Blown*: A decrease of 3.5 per cent is shown in the preliminary $32,432,288.35 reported for September, 1959, when compared with the previous month's adjusted $33,628,932.96. *Glass Products Made of Purchased Glass*: A preliminary figure of $4,893,386.89 was reported for September, 1959. This is an increase of 3.5 per cent when compared with the adjusted figure of $4,725,786.45 for August, 1959.

Glass Container Production based on figures released by the Bureau of the Census, Industry Division, was 13,450,000 gross during October, 1959. This is an increase of 13.6 per cent over the previous month's production figure of 11,832,000 gross. During October, 1958, glass container production was 13,217,000 gross, or 1.7 per cent less than the October, 1959, figure. At the end of the first ten months of 1959, glass container manufacturers have produced a preliminary total of 129,714,000 gross. This is 5.8 per cent more than the 122,524,000 gross produced during the same period in 1958.

Glass Container Shipments during October, 1959, came to 12,092,000 gross, a decrease of 3.2 per cent under September, 1959. Shipments during October, 1958, amounted to 12,993,000 gross, or 3.9 per cent more than September, 1959. At the end of the first ten months of 1959, shipments have reached a premliminary total of 131,571,000 gross, which is 8.5 per cent more than the 121,248,000 gross shipped during the same period the previous year.

Stocks on hand at the end of October, 1959, came to 15,726,000 gross. This is 9.1 per cent more than the 14,403,000 gross on hand at the end of September, 1959, and 13.4 per cent less than the 18,176,000 gross on hand at the end of October, 1958.

GLASS DIVISION MEETING

(*Continued from page* 688)

did not decrease, but rather increased by 8 per cent in the temperature range 75°F to 1800°F. The highest modulus measured was 17.0 x 10^6 psi for Imperial NO672 fibers, and the lowest was 10.7 x 10^6 psi for Bjorksten silica fibers. In order of increasing modulus the four glasses were ranked as follows: silica, E-glass, N-37B, and N-672.

Static fatigue or stress-rupture measurements on all fibers at elevated temperatures and for load durations from one minute to 20 hours showed that tensile strength at constant temperature decreased as a logarithmic function of time or load duration. The tensile strength also decreased as temperature increased, and the approximate stress for short load durations may be predicted from the tensile strength vs. temperature relation obtained on tensile tests.

In general, the breaking stress decreased at a rate between 15,000 and 25,000 psi per log decade of time even at high temperatures. Tensile stresses at 75°F in dry air were generally 10 per cent higher than tests in air at 50 per cent relative humidity, but no significant differences due to ambient air humidity was found for tests at high temperatures.

The Effect of Chemical Composition on the Strength and Static Fatigue of Soda-Lima Glass, by M. Watanabe, R. V. Caporali, and R. E. Mould, Preston Laboratories, Inc., Butler, Pennsylvania. Part I of the paper, "Experimental Methods and Results," was presented by R. V. Caporali. Various glasses in the soda-lima silica system were melted and formed into rods utilizing a continuous drawing apparatus designed to produce rods with an untouched, pristine surface about 3 inches in length. The diameter of the rods was maintained between 0.050 and 0.080 inches. After drawing, the specimens were annealed and given a standard abrasion treatment. Their strength was then measured both immersed in liquid nitrogen before and after aging and immersed in distilled water at various load durations after aging.

Under all test conditions the region of high strength was in the range of about 20-30 per cent CaO and 10-25 per cent Na_2O. Strength differences over the entire range of composition studied were 89, 45, and 30 per cent for the liquid nitrogen tests unaged, liquid nitrogen tests aged, and wet tests aged, respectively. The last test condition is believed most nearly to reproduce the usual practical situation.

In addition to the presentation of these systematic results, the effect of several factors (including homogeneity, length of storage after drawing, amount of disannealing strain) encountered during the study was mentioned.

The Effect of Chemical Composition on the Strength and Static Fatigue of Soda-Lima Glass, by M. Watanabe, R. V. Caporali, and R. E. Mould, Part II, "Analysis of Data and Discussion," being presented by R. E. Mould. A systematic study of the strength and static fatigue of experimentally melted glasses covering the entire glassy range of the soda-lime-silica system was described.

Because the chemical interactions of both aging and static fatigue are eliminated when the strength is measured for freshly abraded specimens immersed in liquid nitrogen, it is this strength value which would be expected to reflect most clearly the mechanical properties of the various glasses. Over most of the composition range studied, this strength was found to be proportional to the square root of Young's Modulus times the surface energy for each glass consistent with the Griffith theory.

A comparison of the strength in liquid nitrogen of freshly abraded specimens with that of specimens containing aged abrasions indicated a strong dependence on the Na_2O content of the aging behavior of fresh abrasions. This finding was consistent with the view that aging is produced by a rounding of the tips of the abrasion cracks under the corrosive action of water vapor aided by the presence of the Na^+ ion.

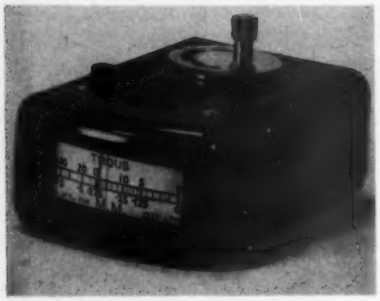
The effect of composition on static fatigue was isolated by comparing the strength of aged specimens tested wet at a specified load duration with that for similar specimens tested in liquid nitrogen. In this way static fatigue was shown to be only slightly dependent on composition and passed through a maximum at about 25 per cent Na_2O. When plotted in the reduced form, all of the static fatigue curves for the various glasses fitted the "universal fatigue curve."

Studies of Nucleation and Growth of Crystals in Glass, by Francis C. Lin, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. Nucleation and growth of crystals wre observed and studied in two glass systems. The theory of the nucleation mechanism as related to the crystallization of a supercooled melt was discussed, with nuclei formation in glass apparently similar to the phenomena observed in the nucleation of a solid solution. The average size of crystals was found to be a linear function of time during a constant temperature heat treatment. The rate of crystal growth versus time followed a typical bell-shaped curve. It was stated that practically any glass could be converted to a crystalline ceramic by the addition of appropriate nucleating agents, suitable means of inducing nucleation, and subsequent heat treatments. The change of physical properties of the glass was observed as a result of crystal formation. The measurements showed a significant increase in thermal expansion, d.c. resistivity, and viscosity. Photomicrographs illustrating this nucleation and crystal growth phenomena were presented. Nucleation centers were shown in several electromicrographs.

Neo-Ceramic Glasses, by Bh. V. Janakirama Rao, International Resistance Company, Philadelphia, Pennsylvania. "Neo-Ceramic" is an arbitrary choice of a coined word which refers to a partially devitrified glass product. Properties of glass compositions which lend themselves to controlled devitrification in the system $SiO_2.K_2O.TiO_2$ were studied. Areas of neo-ceramic glass compositions in other ternary systems like $GeO_2.K_2O.Ta_2O_5$ and $Bi_2O_3.CdO.SiO_2$ were demarcated and their physical properties determined. The influence of various devitrifying agents in binary, ternary, and multicomponent systems was studied. Study of physical properties before and after controlled devitrification by heat treatment indicated that the neo-ceramic acquired useful properties different from those of its glassy state.

(*Continued on page* 720)

NEW EQUIPMENT AND SUPPLIES



Thickness Gauge

O. Hommel Co., Carnegie, Pa., has introduced a single-probe miniature layer thickness meter for measurements on curved surfaces. The instrument can be used on magnetic material between the extremes of electrical sheet steel and cast iron and on non-magnetic coating material such as paint, enamel, lacquer, plastic or non-ferrous metals.

It is available in three measurement ranges: 0 to 5 thousandths of an inch, 0 to 10 thousandths of an inch, and 0 to 30 thousandths of an inch. A pointer clamp traps the pointer in the deflected position so the coating thickness can be read when the instrument is removed from any position where the scale cannot be seen for a direct reading.

Vacuum-Furnace

General Electric, Schenectady, N. Y., has developed a refractory-free, high-temperature vacuum furnace for critical heat treating which operates at temperatures up to 4200°F. It is designed for use in laboratories or for production work where vacuum operation is required. The furnace can process parts or material up to 10 inches in diameter by 10 inches in height, weighing up to 50 pounds. The heating space is 15 inches in diameter by 16 inches high for uniform temperature in the load area. Typical applications include heat treating and degassing of metals and ceramics.

Pollucite Ore

American Potash & Chemical Corp., Los Angeles, Calif., has available high grade pollucite ore developed from deposits in Southern Rhodesia, Africa. The deposit is said to be one of the largest in the world and the pollucite averages 24.4 per cent cesium oxide.

High-Solvency Cleaner

Minnesota Mining & Mfg., Co., St. Paul, Minn., has available an oil-free, high-solvency cleaner designed for the complete cleaning of metal, glass, and masonry building surfaces prior to the application of two-part liquid polysylphide type sealers. It has a flash point above 80°C.

Thermocouple Wire

Pyrometer Co., Pendel, Pa., has available an insulated thermocouple wire said to be effective in applications where severe mechanical loading or vibration would damage conventional themocouple wire. The wire is conventionally insulated and sheathed in metal tubing. It is supplied in all base metal calibrations in single or duplex pairs. Standard diameters are ⅛ in., 3/16 and ¼ in., and the wire is available in lengths up to 50 feet.

Semiconductor Enclosure

Corning Glass Works, Corning, N. Y., has developed a black glass for enclosure of silicon semiconductor devices said to filter out virtually all wavelengths of the ultraviolet, visible and near infrared spectrum, eliminate the need to paint the devices, and solve the costly problem of surface rub-off or scratching.

The glass has a thermal coefficient of expansion of 92 x 10^{-7}/°C; softening point of approximately 675°C; annealing point approximately 495°C, and a strain point of about 455°C. The bead O.D. is .053 (±.002) and I.D. is .023 (±.002). The case is O.D. .095 (±.002) and the I.D. is .060 (±.002).

CATALOGS RECEIVED

Level transmitters. (4 pages) Describes pneumatic force-balance transmitters for measurement of level over range spans of one inch H_2O to 2000 in. H_2O. Illustrations and diagram.
BAILEY METER CO., Cleveland, O.

Bearing blocks. (16 pages) Description of 15 types and 300 sizes of solid, split, gibbed, angle or flanged pillow blocks for commercial shafting up to 12 in. in diameter. Included is line of babbitted, bronze and plain bearing blocks and takeups. Illustrations, design features, specifications, weights and diagrams.
LINK-BELT CO., Chicago, Ill.

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AIR SYSTEMS
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(*Continued from page* 717)

SYMPOSIUM

The Friday morning session of the Symposium on Radiation Effects was under the chairmanship of Norbert J. Kreidl, Bausch & Lomb Optical Company.

Effects of Electron Bombardment on Properties of Various Glasses, by T. M. Mike and B. L. Steierman, Owens-Illinois Glass Company, Toledo, Ohio, and E. F. Degering, Quartermaster Research and Engineering Center, Natick, Massachussets. Presented by T. M. Mike. The purpose of this investigation was to make a preliminary study of the effects of cathode ray bombardment on physical and chemical properties of various glasses. The results indicated the effect of irradiation on bottle serviceability and have practical significance in view of the potential use of glass containers for products that can be sterilized in the package by high energy radiations. This report described the procedures used and results obtained from tests of irradiated glass rod samples.

The several properties that were investigated as a function of radiation dosage and glass type were flexural strength, density, chemical durability, heat of solution, and electrical resistivity. The results showed that for dosages up to 300 megareps there was no important effect on any properties measured.

The Quatermaster Research and Engineering Center performed the irradiations while the testing was done by Owens-Illinois.

Effects of Electron Bombardment on Elasticity and Mechanical Damping of Certain Glasses, by S. W. Barber and K. E. Forry, Owens-Illinois Glass Company, Toledo, Ohio, and E. F. Degering, Quartermaster Research and Engineering Center, Natick, Massachussets. Presented by Mr. Barber. The general study of effects of electron bombardment on properties of various glasses reported by Mike, Steierman, and Degering was extended to include effects on anelastic properties of Pyrex and a lead-containing glass.

Pyrex and a lead-containing silicate glass were exposed to various dosages of 2-mev. electrons, and the effects on the logarithmic decrement and period of a freely oscillating torsional pendulum in which each was made the torsional member were noted. These effects, in both glasses, were qualitatively described as disannealing. Quantitatively, tan δ was increased 10 to 15% in Pyrex and 30 to 60% in the lead glass, and the corresponding decreases in rigidity were of the order of 0.4 per cent and 2 per cent, respectively. In both glasses the mechanical effects and the associated brownish color annealed out in about 20 hours at 500°F. Also, there were some completely unexpected effects which were reported here for the first time and should be verified by others. These consisted of (1) changes in the shape of tan δ vs. temperature curves caused not only by thermal treatment but also by changes in period of the pendulum and (2) fine structure in the tan δ vs. temperature maxima owing to sodium ion diffusion. These details complicate the interpretation of such maxima and, if verified, will justify a re-examination of the anelastic behavior of glasses in general and Pyrex in particular.

Survey of Glasses for High Level Gamma Radiation Dosimeters, by J. F. Kircher, Battelle Memorial Institute, Columbus, Ohio. In selecting candidate glasses which might serve to measure relatively high dosages of gamma radiation, compositions were chosen which contained ions having more than one valence. In such glasses, radiation can produce changes in the oxidation state of one or more ions and thus cause changes in the optical-absorption spectrum.

Ions such as Ce^{4+} and Fe^{3+} inhibit the darkening of glass by accepting electrons which might otherwise be loosely held and, therefore, free to absorb energy and thus cause darkening. These observations suggest that the introduction of a relatively large proportion of variable-valence ions would inhibit coloration at low exposures but permit the formation of stable color centers at high exposures, thus providing a high-level dosimeter.

The radiation source was cobalt-60 in rod form encapsulated in stainless steel and housed in a water pool about 14 feet deep. The rods had an active length of 8 inches and were arranged in various configurations to accommodate the specimens and provide the desired dose rate.

The heat treatment selected for each glass studied was based on somewhat limited annealing trials to establish a temperature at which the optical density of all specimens in a series would be reduced to a measureable level. The temperature selected, therefore, may not have been optimum for each glass.

On the basis of the experimental results, it appeared that an antimony glass and Corning Code 8392 glass could be utilized for dosimeters at high integrated dosages. In addition, antimonate glasses containing MnO_2, Co_3O_4, As_2O_3, or ReO_2 as additives showed considerable promise for dosimeter use in the range of 10^6 to 10^9 rads or higher. The experimental results further indicated that by the proper selection of the kind and quantity of variable-valence oxide glasses can be made which will serve as dosimeters at selected levels of dosage. The maximum dosage measurable by such glasses is probably considerably greater than any reached in the investigation.

Applications of Radiation Effects in Low and High Level Dosimetry, by G. E. Blair, Bausch and Lomb Optical Company, Rochester, New York. From previous studies it seemed apparent that certain ions would be useful for dosimeter glasses. Three main requirements were considered essential: (1) sensitivity of change of property consistent with easy measurement (2) linearity of this change with dose, (3) stability of this change with storage time. The first requirement was met by most of the transition elements in conventional glasses, but the absorption change became non-linear above approximately 5×10^5, and fading, although decreased from that of silver glass, was still several per cent when stored one day after irradiation at room temperature. Next, compositions derived from a field in the ternary system R_2O — B_2O_3 — SiO_2 were investigated. When activated with transition elements, these compositions showed both increased range of linearity of response and reduced fading. A base glass composed of SiO_2, Na_2O, B_2O_3, and Al_2O_3 was selected. The sensitivity of some of the glasses studied was shown. It was noted that the sensitivity could be changed by the concentration of the activator ion as shown for cobalt and cerium, with cobalt

Soon To Be Published

Vol. II. HANDBOOK OF GLASS MANUFACTURE

Volume I of the Handbook of Glass Manufacture was originally published in 1953 by the Ogden Publishing Company. Uninterrupted demand for the book necessitated a second printing in 1957 in order to meet the needs of all those concerned with glass manufacture, technology and engineering. Both the first and second printing of Volume I have been sold out.

As a supplement to the first edition, Volume II of the Handbook of Glass Manufacture will be published on or about March 1, 1960, and will again be edited by Dr. Fay V. Tooley, Professor of Glass Technology, Department of Ceramic Engineering, University of Illinois.

CONTENTS . . .

Chemical and Instrumental Analysis of Glass
Francis Glaze, National Bureau of Standards
John Time, Owens-Corning Fiberglas Corp.

Optical Properties of Glass: Effects of Radiation on Glass
Norbert J. Kreidl, Bausch and Lomb Optical Co.

Scientific Glass Blowing
Vincent DeMaria, Glass Products Development Laboratory

Flat Glass Manufacturing Processes
Roy G. Ehman, Pennsylvania State University

The Quality Control Chart
Ronald Wiley, Owens-Corning Fiberglas Corp.

Electric Melting of Glass
Larry Penberthy, Penberthy Instrument Co.

Constitution and Structure of Glass
Fay V. Tooley, University of Illinois

The Glass Industry
55 West 42nd Street, New York 36, New York

Date .....

Enclosed please find remittance in the amount of $..... to cover the cost of ..... copy(ies) of Volume II of the HANDBOOK OF GLASS MANUFACTURE. Single copy price, $10.00. Order for 5 or more copies, 10% discount. Add Shipping and Insurance charges, domestic 60¢; foreign 90¢. Foreign remittance in U. S. dollars.

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the more efficient activator. It was also found that the cobalt-activated borosilicate glass was the most stable and showed the best linearity of response of the group. Fading of the silver-activated phosphate, cobalt-activated silicate, and cobalt-activated borosilicate glasses was compared.

Radiation Dosimeter Glasses, by J. Paymal, M. Bonnaud, and P. LeClerc, St. Gobain, Paris, France. An abstract of the paper was presented by V. Garino-Canina, St. Gobain, Paris, France. There have been reported various elements useful in revealing ionization phenomena, e. g., manganese, cobalt, vanadium and titanium.

The following colorants were studied:

Ti	V	Cr	Mn	Fe	Ni				
Cu	As	Se	Mo	Ag	Cd	Sb	W	Au	

These elements were introduced into plate glass compositions, fused in an oxidizing or reducing atmosphere, or in classical colored glass compositions.

From these preliminary experiments it was found that the most spectacular elements were Mn, V, Cr, modified more or less strongly by Fe and Ce. It was also found that arsenic affected unfavorably the stability of the radiation induced coloration and that fusion under reducing conditions generally made the glasses less colorable.

The action of gamma rays on the coloration of glass was likened to that of UV light in solarization. The solarization process in glasses is attributed to electron transfer between ions of multiple valence, with the classical example being the purple color developed by the exposure of manganese glasses to sunlight.

Glasses were described containing primarily manganese as well as those containing both manganese and vanadium.

FRIDAY AFTERNOON

Friday afternoon was devoted to a workshop "Strength Measurements." This session was guided by Neill M. Brandt, Research Center, American Optical Company, Southbridge, Massachusetts. This workshop presentation was designed primarily to review and discuss techniques and methods of making strength measurements. Those participating formally in the program were:

Participant	Company	Discussed
R. Southwick	Preston Laboratories	Lath bending and variables to be controlled
J. McCartney	Corning Glass Works	Bending of rods
L. Orr and Zukoff	Pittsburgh Plate Glass	Bending of plates and use of the concentric ring method
N. Brandt	American Optical Co.	Analysis of disk fracture showing many excellent pictures
W. H. Otto (reviewed by N. Brandt in absence of Otto)	Owens-Corning Fiberglas	Reviewed fiber tension method and method of analysis
M. Kerper	National Bureau of Standards	Described elevated temperature measurements
R. E. Mould	Preston Laboratories	Pointed out the many contributing variables that influence most strength tests

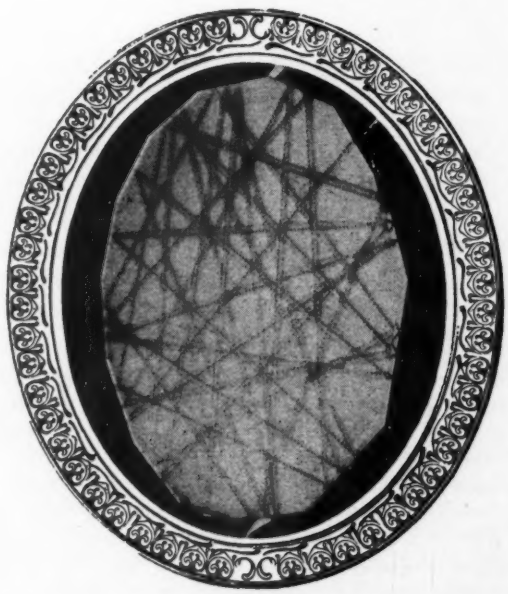
The discussion which followed proved that this type of workshop is quite popular. The extensive variables,

How well do you know your glass?

THIS IS A:

- ☐ 1. Fused silica delay line
- ☐ 2. Coffee table
- ☐ 3. Diagram of molecular activity
- ☐ 4. New type of cooking surface

Stop on No. 1. This is an ultrasonic delay line made of pure, fused silica glass. The delay line converts radar into a sound beam and bounces it along the path of the dotted lines; an electrical computer compares the delayed signal with others to differentiate between moving and stationary targets. Throughout nearly 70 years as a supplier of soda ash to the glass industry, Wyandotte has seen glass research solve countless problems of incredible complexity. Today, as in the past, Wyandotte is a working partner supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.



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however, involved in any strength measurement of glass indicate that much more work should be done on these tests before concordant results may be expected.

The banquet was well attended on Thursday night. The Frank Forrest Award for 1959 was presented to C. L. Babcock and D. A. McGraw, Owens-Illinois Glass Company, for their studies on the application of physical properties to forming of glass. The S. B. Meyer Jr. Award for 1959 was made to E. M. Levine and Stanley Block, National Bureau of Standards, for their studies on immiscibility in various oxide systems. The awards were presented by A. C. Siefert, Trustee of the Glass Division. Joseph Wright, Owens-Illinois Glass Company, was made a Fellow of the American Ceramic Society. This honor was conferred by Mr. G. H. Spencer-Strong, President-Elect of the Society. The award was accepted by W. B. Silverman as Mr. Wright was unable to be present.

Golf prizes and door prizes were also awarded at the banquet, and an interesting movie showing operations of old and modern Owens' bottle machines was presented. The banquet was ably directed by F. R. Bacon, chairman of the Glass Division.

The next meeting of the Society will take place in Philadelphia, Pennsylvania, April 24-28, 1960.

ELECTRONICS

(*Continued from page* 700)

The value of electronic equipment going into military aircraft has remained stable over recent years. During fiscal 1958, this value increase to $1.446 billion, up from $1.083 billion during fiscal 1957.

Missile Electronics

Total procurement of missiles continues to expand at a rapid rate—from $718 million during fiscal 1955 to $2.9 billion during fiscal 1958. At least $3.3 billion will be spent for missiles during fiscal 1959 increasing to $3.8 billion during fiscal 1960. The electronic portion of the missiles has increased even more rapidly—from $306 million during fiscal 1955 to $1,268 billion during fiscal 1958. Electronic missile dollars should exceed $1.5 billion during fiscal 1959 to reach nearly $2 billion during fiscal 1960.

With $800 million more for missile production and research the fiscal 1960 budget will continue to support the Atlas and Polaris programs. The budget also will provide for a 50 per cent increase in funds for the Titan ICBM and a 40 per cent increase for the Minuteman ICBM. Additional funds will be directed into the Bomarc, Nike-Hercules, and Hawk missile systems. The fiscal 1960 budget requests funds to complete the present Thor and Jupiter ICBM programs.

Other Military Electronics

Continuing emphasis on more advanced and complex ship equipment ensures electronics another growing military market. Sales of electronic equipment for military ships and harbor craft during fiscal 1958 registered a $20 million increase over fiscal 1957, totaling $99 million.

Electronic research and development expenditures have

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will be published as a supplement to the January, 1960, issue.

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steadily risen from $270 million during fiscal 1955 to $390 million during fiscal 1958. Basic research, missile research and development, and the operation of R & D test facilities take an increasing share of the R & D budget. The proportion of the total effort to be devoted to research on aircraft and related equipment, conventional weapons and ammunition will be smaller.

DRY COMPRESSED AIR

(*Continued from page* 690)

densation on the cylinder walls even though well water at 60°F is used in the jackets. When cold well water is used for jacket cooling, it is necessary to make sure that during start-up there is no condensation or rust on the cylinder walls, because of problems with rings and lubrication. In addition to the clean, dry, cold inlet air, the lubrication problem is greatly reduced. Regardless of the outdoor air temperature, the amount of lubrication can be correctly adjusted so that there will be just enough. In the case where non-lubricated compressors are used, rust or iron-oxide definitely shortens the life of the rings.

The most important factor, however, from the air compressor service, is the matter of discharge temperature. According to one manufacturer's statement, no absolute maximum temperature can be set. This will depend on the discharge pressure, number of stages, inlet temperature, operating speed, and whether designed for air or water cooling. The maximum discharge temperature for heavy duty process equipment should run well under 350°F.

However, from information published in *Compressed Air and Hydraulics* in April, 1957, it appears that the maximum delivered air temperature should not be over 320°F. It has been found that by refrigerating the intake air to 40°F at an installation of a 700 HP single stage air compressor which has been in operation over three years, the discharge temperature runs up to 305°F. In almost every installation where the intake air exceeds 45°F, the temperature at the discharge will exceed 320°F and there will be a possibility of an internal oil fire. There are many installations in this country that have experienced fires and explosions in their compressed air installations, but when the intake air is properly dried and cooled, this condition should be at a minimum. Quoting from the April 1957, report, the conditions under which a fire or explosion of this nature can originate are:

a. A compressed air pipe or chamber containing iron oxide impregnated with lubricating oil.
b. The temperature of the compressed air flowing through the chamber being 320°F or higher. This may be naturally so with single-stage compressors or can easily occur in a multi-stage compressor if any of the valves are defective.

"This mixture of iron oxide and lubricating oil and hot air can produce a catalytic action which immediately creates a local exo-thermic heat rise and results in the release of highly volatile peroxides from the oil, which can quite easily ignite. Below this critical temperature of 320°F, this phenomenon does not occur."

Air-Operated Equipment

It is a fundamental principle of Thermodynamics that the efficiency of a heat engine (air powered machine or tool) is improved as its temperature of energy supply is increased. For a reversible heat engine cycle the efficiency may be expressed in terms of temperature.

$$e = \frac{T_1 - T_2}{T_1}$$

where e = Efficiency
T_1 = Absolute Temperature at which heat energy is supplied
T_2 = Absolute Temperature at which heat energy is rejected.

By drying and chilling the air *before* compression, the Dry Air System effects a gain in compressor performance so that more weight of air can be handled with the same compressor horse power. This is evident from a consideration of the equation defining the work of a compressor.

$$W = \frac{wRT}{1-n}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

W = Work required by Compressor in Ft. #/Min.
w = Weight of air compressed in #/Min.
R = Gas constant
T = Inlet Absolute Temperature of air to compressor
P_2 = Compressor discharge pressure
P_1 = Compressor suction pressure
n = Process constant for the compressor

For a given compressor, the pressure ratio P_2/P_1, R, and n are constant and the work of compression becomes a direct function of the product wT. Therefore, for a given horse power, the product wT will be a constant, and as the inlet temperature is decreased, the weight compressed may be increased.

Refrigeration Requirements

The economics of operating the refrigeration system to pre-cool and pre-dry the intake air has always been a matter of discussion.

Depending on the location, refrigeration may be required as much as twelve months during the year in some parts of the country; in others, as much as 9 or 10 months. Table II presents the data for Pittsburgh, Pennsylvania, as a typical area and divides the cooling load into the four seasons.

Table II

FOR PITTSBURGH, PENNSYLVANIA

	Temp. °F.	Relative Humidity	Wet Bulb
Summer	82	61%	72°F.
Autumn	55	62%	49°F.
Winter	32	72%	29°F.
Spring	51	62%	45°F.
Average	53	65%	47°F.

In the summer the design wet bulb condition would be 72°F; in autumn, 49°F; in the spring, 45°F; and during the winter, 29°F. It is obvious that during the winter operation—approximately two or three months—no refrigeration is required because the intake is below 38°F. The average for the year has a design wet bulb condition of 47°F so that the refrigeration horse power required to

operate the cooling system amounts to less than 3 HP per 1000 cubic feet of air to be cooled from 47°F wet bulb to 38°F.

Whenever possible, therefore, glass manufacturers install dual refrigeration systems, which together will have sufficient capacity to refrigerate the intake air during the summer time; during the other seasons of the year, a single refrigeration compressor in the dual system will more than carry the load.

A further advantage in using the dual refrigeration system is that there is a 100 per cent stand-by for more than 80 per cent of the time, and it is possible to alternate the compressor systems so as to even the operating time on each machine.

Brockway Glass Company is operating three Coblentz Dry Air installations for example, in locations of high humidity.

According to the company, a 200°F temperature at the point of use (as delivered by this dry air system) will increase the work any amount of air can do. By using the heat of compression for useful work, compressed air will ordinarily be saved. As the compressed air temperature increases, more thermal efficiency is obtained.

Knox Glass, Inc., which recently made a dry air installation in Danielson, Connecticut, is operating one JK (a redesign of the Lynch JP style machine), two W-D and two model 10 production machines. They are accomplishing this with 225 HP of input power to the compressors.

The two compressors are an Ingersoll-Rand 14 x 12 duplex and an Ingersoll-Rand 19 x 13 single. The first machine is driven by 125 HP motor and the other by a 100 HP motor. In the latter case, the 19 x 13 has been fitted with valve spacers to keep the horse power at an acceptable level; however, even with five machines on the line, it is unloaded in approximately ⅓ the operating time.

According to Knox the supply of dry air at low temperatures by means of this system improves the efficiency of the compressors and reduces the contraction which occurs when the air is cooled to remove moisture in other systems. They are currently using the air at approximately 170°F and feel that further savings could be made by insulating the lines so as to use the air at temperatures approaching 200°F.

In a glass plant, where different types of glass-forming machines are operating, almost all of them use compressed air.

It is necessary to have dry air for operating an I.S. machine, or any other machine made of ferrous material, using cylinders or rotary mechanisms, since moisture corrodes material containing iron.

There are installations operating in the United States in which the glass-forming machines are run continuously, even though no ware is being formed—because it is so difficult to start the machines once they have been stopped. The oil-water sludge forms in the control valves and in the cylinders of the air-operated bottle machines, and prevents immediate start-up.

The cost of down-time in a typical glass manufacturing plant averages about $2,000 in lost production per machine per day.

Glass companies have found that when using dry com-

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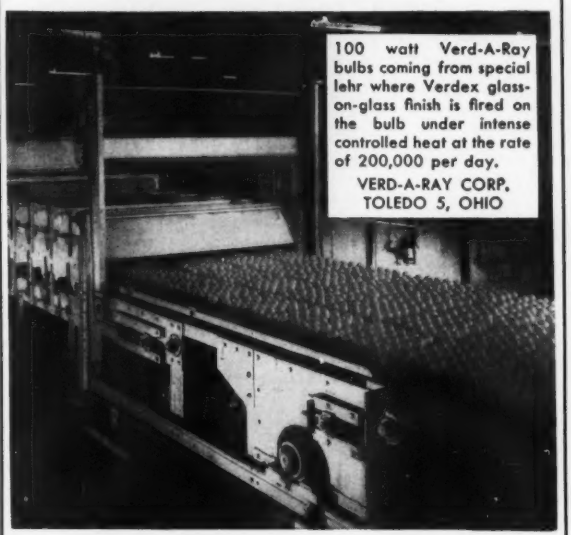
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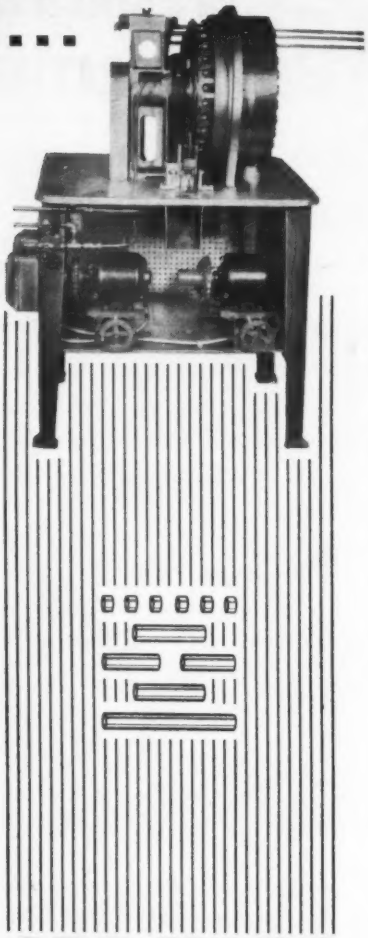

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pressed air, they can start or stop the air-operated bottle equipment any time of the year, and can therefore operate glass-forming machinery for longer periods of time at maximum speed, with minimum maintenance. In addition, the dry compressed air is uniform in temperature, moisture, pressure and volume.

NICKEL AND COBALT FILMS

(*Continued from page* 697)

Example 1

	Moles 1 Liter
Nickel sulphate	0.07
Sodium hypophosphite	0.23
Lactic acid	0.21
Succinic acid	0.12

The pH of the solution is 5.5 and adjusted with sodium hydroxide or with sulphuric acid.

Example 2

	Moles 1 Liter
Nickel sulphate	0.09
Sodium hypophosphite	0.23
Lactic acid	0.30
Sodium succinate	0.12

The pH of this solution is 4.7 and it is adjusted with either sodium hydroxide or sulphuric acid.

Example 3

	Moles 1 Liter
Nickel sulphate	0.07
Sodium hypophosphite	0.23
Lactic acid	0.21
Malic acid	0.06
Succinic acid	0.02

The pH of the present solution is 4.5 and it is adjusted with either sodium hydroxide or sulphuric acid.

(*To be continued*)

GLASS ORNAMENTS

(*Continued from page* 692)

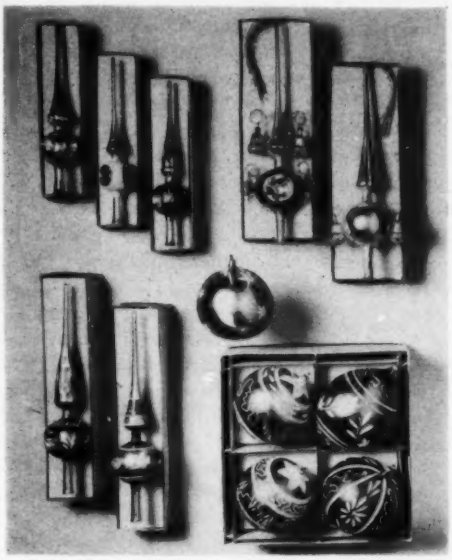
are also press molded when it is necessary to form special, indented shapes. The wall of the Christmas ball, however, is so thin that the design must be applied with very slight pressure.

Before the glass ball can be decorated on the outside, it must first have an internal coating (wash), of silver nitrate which adds depth to the surface of the Christmas ball by producing a mirrored effect and making the colored lacquer opaque.

After the outside lacquer is added, the ball is placed on a conveyor belt which runs under a series of lights for drying, and the ornament is then ready to be decorated by the silk screen, or stencil, method in which the design is first "printed" on a silk or nylon screen by means of a light-sensitive emulsion. The screen is stretched across a wooden frame which is fastened to a semi-automatic machine. As the glass Christmas ball is rotated, the screen moves at the same speed as the surface of the ball. There is a rubber squeegee within the screen frame that forces the paint through the open areas

of the silk (which are not covered by the printed design), and the design is impressed on the glass.

Because we are dealing with a sphere in decorating Christmas balls, the screen must have a center depression conforming to the particular glass ball being decorated.



Imported hand-painted Christmas Ornaments

Naturally, the screen can contact only the area near the circumference of the ball as it rotates, and that is why all machine-decorated spherical ornaments have designs only around the center. To decorate near the top or bottom of the ornament, the striping method is used in which a brush replaces the silk screen.

In addition to stencil printing and striping, there are several other methods, like spraying and veiling (wavy lines). They are all important to the finished design.

RESEARCH DIGEST

(*Continued from page* 714)

SiO_2 as shown by the eutectic mixtures which these compounds form:

1. $Na_2O \cdot 2SiO_2 + SiO_2$ and
2. $Na_2O \cdot 2SiO_2 + NaNa_2O \cdot SiO_2$

Minor substitutes of oxides such as K_2O and B_2O_3 for Na_2O in a normal soda-lime glass composition give rise to differential thermal analysis curves showing the characteristics of a glass of higher Na_2O content. Differential thermal analysis curves show that the addition of some refining agents to glass batches reduces the initial glass-melting reactions by 50 to 100°C (75 to 180°F).

Strict control of batch preparation has resulted in increased productivity. The flame photometric analysis of glass batches may prove to be a more rapid technique suitable for routine control.

Considerable difficulty is encountered in representing tank furnaces accurately by models. The use of tracers, such as lithia, in the glass batch is recommended especially for determining different flow patterns in air-cooled tanks and thermally insulated tanks.

The rate of corrosion of tank block refractories by soda glasses is diffusion-controlled by Na + ions, and

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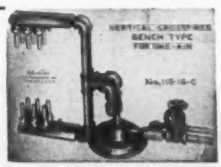

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the depth of flux-line attack is directly proportional to the apparent porosity of the material. The corrosion zones of the mullite-type refractories in soda-containing glass show either:

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2. — mullite and nephelite (or carnegeite) in a glass matrix.

depending upon the concentrations of Na + or Na_2O at the refractory interface. Pure tank blocks of low porosity give the best service.

4. *Flowing Processes in Forming of Glass and their Study*, by Schlieren, Pictures by W. Giegerich.

The flow of glass during the fabrication of containers is determined by the viscosity and its variation with temperature and time, and shape of the parison and the number and complexity of cords in the glass.

A great number of Schlieren-pictures (shadow pictures) have been taken at different stages of production, e. g. when filling the blank mold, enter by a gob or parison or by suction involving the use of shears in either case, and blowing in the blank or blow mold. The pictures give a clear view of the course of the operations. The influence of the profile of the mould and of the other properties of its surface is shown. Schlieren-pictures show further that by the forming process the cords, formerly situated irregularly, are given a new direction.

5. *Analysis of Inhomogeneities in Glass by a Combination of Etching and Optical Interference Methods*, by J. Löffler.

The rate of dissolution of glasses of different composition varies as well as that of the striae or cords which it contains. It is possible to use this fact for the analysis of inhomogeneities in glass. The reagents used are: 1 per cent hydrofluoric acid and a mixture of 40 per cent fluoboric (HBF_3OH) and 22 per cent hydrochloric acids. Both these reagents leave silica-rich striae and inhomogeneities as "steep and elongated hills", the height of which is the same for both reagents. Alumina-rich inhomogenities are left as "hills" by hydrofluoric acid but are eroded as "valleys" by the mixture of fluoboric and hydrochloric acids. The increase of the silica and alumina contents may be deduced from the height of the profile thus obtained; this height varies with each basic glass composition. The measurement of the profile is carried out by means of an interference microscope.

NEW PRODUCTS

(*Continued from page* 701)

Glass pipe and fittings are made from heavy wall tubing which is machine drawn to assure uniformity. The end flanges are accurately pressed and finished pieces which are electrically sealed to the tubing. The ends of all straight lengths and all standard fittings (except U-bends) are heat treated for extra strength.

Glass pipe is corrosion-resistant against all chemicals and combinations of chemicals except hydrofluoric acid, phosphoric acid with traces of fluoride, and hot concentrated alkalies.

Many industries such as food products, drugs, pharmaceuticals, dairy, wine, photoengraving, as well as various heavy chemical industries are finding many advantages in its use. The most famous installation during the war was at Oak Ridge, the Nation's atomic energy research

center. Here for the first time, glass pipe was tailored at the plant site; seven and one-half miles of pipe were used.

Because of its low coefficient of expansion, it has remarkable ability to withstand thermal shock (sudden temperature changes). Flushing with live steam immediately followed by cold water is a frequently used cleaning procedure.

Normal operating temperatures extend up to 250°F. Installations within this range require no unusual precautions. Operating temperatures may go to 450°F if precautions are taken to protect the pipe from thermal shock. Insulation around the pipe is the usual means of providing this protection.

GCMI MEETING

(*Continued from page* 691)

demand were based on its forecasts of real disposable income which is expected to total $277.1 billion in 1960.

The forecast takes into account a 5.6 per cent rise in disposable personal income to $352.7 billion in 1960 which will be offset by a 2.2 per cent increase in the consumer price index.

Forecasts of glass container demand for 1960 do not take into account further inventory building, a key factor in the high level of glass container shipments in 1959.

Fred N. Dundas, Dominion Glass Company Ltd., GCMI president, reviewed the activities of the Institute in the six months just past.

Commenting on the cooperative advertising program for the new Handy Beer Bottle, he outlined the entire campaign, beginning in 1955 when GCMI had McKinsey & Company study the success of the One-Way Beer Bottle in the Baltimore market and compare it with the Detroit market. In 1958, a more extensive study was completed by the Institute for Motivational Research concerning beer packaging and merchandising in bottles—both returnables and non-returnables—as compared with cans. All beer bottle manufacturers are now cooperating in the program which is to continue through June, 1960.

Other speakers included the Honorable Barry M. Goldwater, United States Senator from Arizona; President J. E. Wallace Sterling of Stanford University; industry representatives; and members of the GCMI staff.

J. Gordon King, Hazel-Atlas Glass division, Continental Can Co., was chairman of the business session committee which included E. M. Terner of Metro Glass Company, and J. C. Ferguson of Laurens Glass Works, Inc.

The social committee was headed by William Simkins, Latchford Glass Company; other members included E. S. Campbell, Northwestern Glass Company; P. D. Griem, Glass Containers Corporation; J. B. Miller, Thatcher Glass Manufacturing Company; and K. C. White, Owens-Illinois Glass Company.

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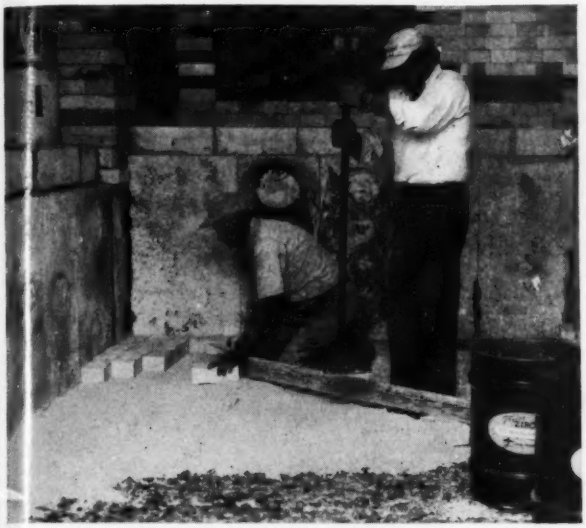
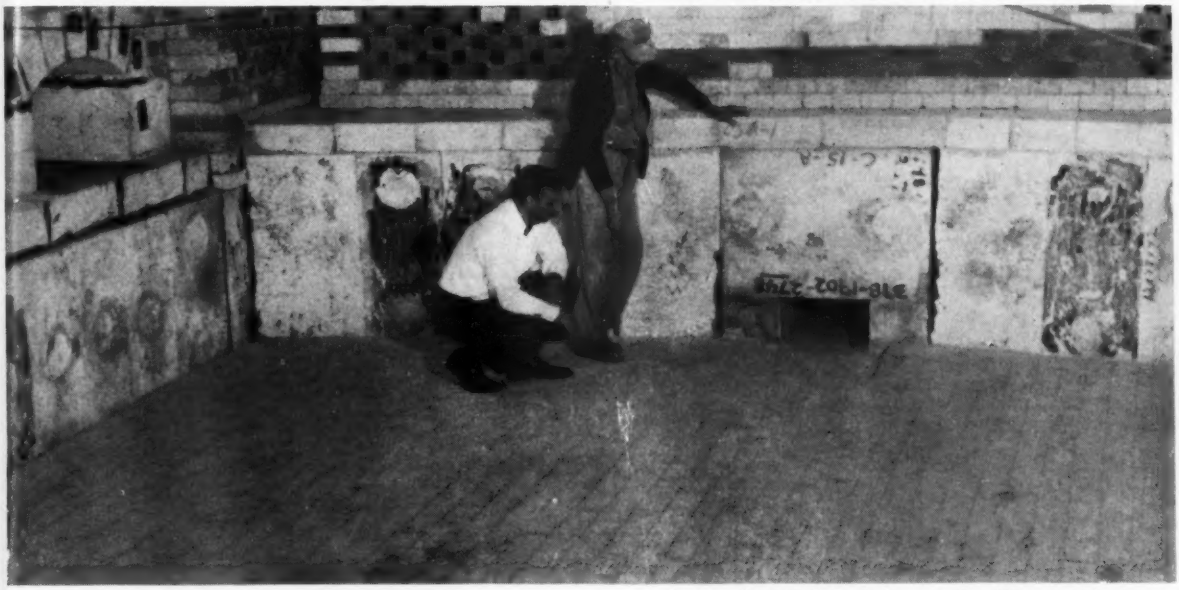
Pennsylvania Glass Sand Corp.	679
Polarizing Instrument Company, Inc., The	727
Selas Corporation of America	683
Sharp-Schurtz Company	728
Surface Combustion Division	708
Taylor Sons Company, Chas., The	Cover III
Toledo Engineering Company	725
Vitro Chemical Company, Sub. Vitro Corp. of America	730
Walsh Refractories Corporation	680
West End Chemical Company	715
Westvaco Chlor-Alkali Division, Food Machinery & Chemical Corp.	682
Wyandotte Chemicals Corp.	722

Have you investigated this way to "pave and save with Taylor Zircon"?



After 31 months' service, old clay bottom of four-port regenerative furnace melting Georgia green glass was leveled off with TAYLOR ZIRCON No. 717-W Ramming Mix.

A slurry of TAYLOR ZIRCON No. 716 Cement was laid over the ramming mix before laying TAYLOR ZIRCON 9 x 4½ x 3" brick with thin, trowelled joints.



Inspection of tight joints and uniform paving of completed melter at throat end.

TAYLOR ZIRCON PAVING over old clay bottoms has been highly successful in opal tanks and flint container and tableware furnaces. Have you investigated this way to "Pave and Save with Taylor Zircon"? Write direct, or call in a Taylor field engineer for full details.

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REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
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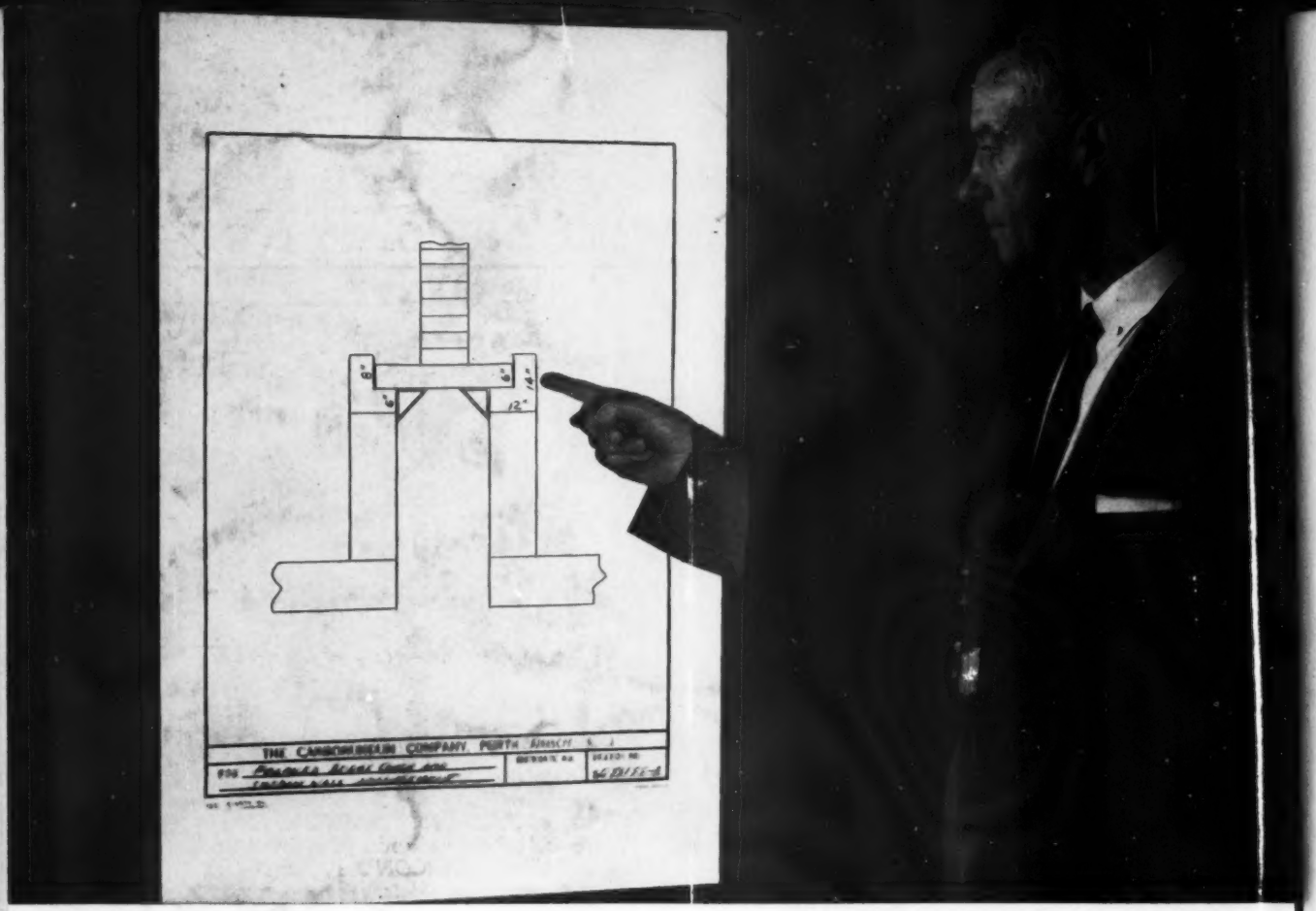

Engineering hints from Carborundum

Bridge-wall design minimizes effects of silica run-down

Effects of silica run-down from the shadow wall are avoided by using L-shaped runner blocks. The cover tile fit into these blocks as shown above. These runners are designed to trap the run-down and thus prevent glass contamination. To insure maximum life and best overall service, both runners and covers are made of MONOFRAX® fused-cast refractories.

Another approach to the same problem is to build the shadow wall of MONOFRAX blocks. The solution adopted depends upon operating conditions as well as the economies to be gained.

Familiarity with all types of glass tank construction is one result of Carborundum's long experience in solving a broad range of refractory problems. Because no two glass tanks operate alike and every critical area has its own specific needs, no one refractory can meet all requirements. That's why MONOFRAX fused-cast refractories are made in *four* distinct types, each designed and recommended for a particular service application.

MONOFRAX S refractory, for example, is a general-purpose material that offers unequalled resistance to erosion and corrosion and exceptional thermal shock resistance for complete melting ends and other vulnerable areas, both above and below the metal line. MONOFRAX M refractory, with its high purity, is recommended for entire refining ends and channels. MONOFRAX H refractory is widely used in the superstructure because of low glassy phase and ability to resist heat shock. MONOFRAX K refractory is offered for special applications, particularly in fiber glass tanks.

Top performance comes from "engineering" refractories to specific service needs. Carborundum has the experience—*and the special-purpose refractories*—to help you get quality glass at the lowest possible refractory cost. For recommendations, contact Department L-129, Refractories Division, Perth Amboy, New Jersey.

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